Biomass Estimates for Sea Cucumber (*Parastichopus californicus, Cucumaria miniata, C. pallida*) as Determined Through Surveys Conducted June 2012 to May 2013

N.M.T. Duprey and L.M. Stanton

Fisheries and Oceans Canada
Science Branch, Pacific Region
Pacific Biological Station
3190 Hammond Bay Road
Nanaimo, BC V9T 6N7
Canada

2015

Canadian Manuscript Report of Fisheries and Aquatic Sciences 3083

Fisheries and Oceans Canada
Pêches et Océans Canada

Canada

Canadian Manuscript Report of Fisheries and Aquatic Sciences

Manuscript reports contain scientific and technical information that contributes to existing knowledge but which deals with national or regional problems. Distribution is restricted to institutions or individuals located in particular regions of Canada. However, no restriction is placed on subject matter, and the series reflects the broad interests and policies of the Department of Fisheries and Oceans, namely, fisheries and aquatic sciences.

Manuscript reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report is abstracted in *Aquatic Sciences and Fisheries Abstracts* and indexed in the Department's annual index to scientific and technical publications.

Numbers 1-900 in this series were issued as Manuscript Reports (Biological Series) of the Biological Board of Canada, and subsequent to 1937 when the name of the Board was changed by Act of Parliament, as Manuscript Reports (Biological Series) of the Fisheries Research Board of Canada. Numbers 1426 - 1550 were issued as Department of Fisheries and the Environment, Fisheries and Marine Service Manuscript Reports. The current series name was changed with report number 1551.

Manuscript reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page. Out-of-stock reports will be supplied for a fee by commercial agents.

Rapport manuscrit canadien des sciences halieutiques et aquatiques

Les rapports manuscrits contiennent des renseignements scientifiques et techniques ques qui constituent une contribution aux connaissances actuelles, mais qui traitent de problèmes nationaux ou régionaux. La distribution en est limitée aux organismes et aux personnes de régions particulières du Canada. Il n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques du ministère des Pêches et des Océans, c'est-à-dire les sciences halieutiques et aquatiques.

Les rapports manuscrits peuvent être cités comme des publications complètes. Le titre exact paraît au-dessus du résumé de chaque rapport. Les rapports manuscrits sont résumés dans la revue *Résumés des sciences aquatiques et halieutiques*, et ils sont classés dans l'index annual des publications scientifiques et techniques du Ministère.

Les numéros 1 à 900 de cette série ont été publiés à titre de manuscrits (série biologique) de l'Office de biologie du Canada, et après le changement de la désignation de cet organisme par décret du Parlement, en 1937, ont été classés comme manuscrits (série biologique) de l'Office des recherches sur les pêcheries du Canada. Les numéros 901 à 1425 ont été publiés à titre de rapports manuscrits de l'Office des recherches sur les pêcheries du Canada. Les numéros 1426 à 1550 sont parus à titre de rapports manuscrits du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 1551.

Les rapports manuscrits sont produits a l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

Canadian Manuscript Report of

Fisheries and Aquatic Sciences 3083

2015

BIOMASS ESTIMATES FOR SEA CUCUMBER (*Parastichopus californicus, Cucumaria miniata, C. pallida*) AS DETERMINED THROUGH SURVEYS CONDUCTED JUNE 2012 TO MAY 2013

by

N.M.T. Duprey and L.M. Stanton

Fisheries and Oceans Canada
Science Branch, Pacific Region
Pacific Biological Station
3190 Hammomd Bay Road
Nanaimo, BC
V9T 6N7

© Her Majesty the Queen in Right of Canada, 2015

Cat. No. Fs97-4/3083E ISBN 978-0-660-03776-6 ISSN 1488-6473

Cat. No. Fs97-4/3083-PDF ISBN 978-0-660-03778-3 ISSN 1488-5387

Correct citation for this publication:

Duprey, N.M.T, and Stanton, L.M. 2015. Biomass estimates for sea cucumber (*Parastichopus californicus, Cucumaria miniata, C. pallida*) as determined through surveys conducted June 2012 to May 2013. Can. Manuscr. Rep. Fish. Aquat. Sci. 3083: viii + 109p.

TABLE OF CONTENTS

ABSTRACT viii
INTRODUCTION 1
METHODS 2
  OPEN SURVEY METHODS 2
    Surveying 2
    Biosampling 3
  SURVEY AREA DESCRIPTIONS 3
    Petrel – South Principe 4
    West Aristazabal 4
    Seaforth – Spiller Channel 4
    Joassa Channel 5
    Tribune Channel 5
    Drury Inlet 5
    Kingcome – Wakeman 6
    Quatsino Sound 6
  DATA ANALYSIS 6
    Density estimations 6
    Mean weight estimations 7
    Biomass estimations 7
RESULTS 7
  DENSITY SURVEYS 7
    PFMA 5–14 (Petrel – South Principe) 8
    PFMA 5–16 (Petrel – South Principe) 9
    PFMA 5–17 (Petrel – South Principe) 10
    PFMA 6–13 (West Aristazabal) 11
    PFMA 7–12 (Seaforth – Spiller Channel) 12
    PFMA 7–13 (Seaforth – Spiller Channel) 13
    PFMA 7–22 and 7–23 (Joassa Channel) 14
    PFMA 12–35 and 12–37 (Tribune Channel) 15
    PFMA 12–36 (Tribune Channel) 16
    PFMA 12–42 (Drury Inlet) 17
    PFMA 12–43 (Kingcome – Wakeman) 18
    PFMA 12–45 and 12–46 (Kingcome – Wakeman) 19
    PFMA 12–47 and 12–48 (Kingcome – Wakeman) 20
    PFMA 27–7 (Quatsino Sound) 21
    PFMA 27–8 (Quatsino Sound) 22
    PFMA 27–9 (Quatsino Sound) 23
    PFMA 27–10 (Quatsino Sound) 24
    PFMA 27–11 (Quatsino Sound) 24
DISCUSSION 26
  Petrel – South Principe 26
  West Aristazabal 26
  Seaforth – Spiller Channel 26
  Joassa Channel 26
  Tribune Channel 27
  Drury Inlet 27

Kingcome – Wakeman 27
Quatsino Sound 27
LITERATURE CITED 28

LIST OF TABLES

Table 1. Total number and ID of transects surveyed, and number of *Parastichopus californicus* biosamples collected in Open surveys conducted June 2012 – May 2013, by Pacific Fishery Management (PFM) Subarea. 30

Table 2. Mean linear *Parastichopus californicus* density estimates by PFM Subarea, with lower (LCB) and upper (UCB) confidence bounds (sea cucumbers per metre of shoreline: c/m-sh) from Open surveys completed June 2012 – May 2013.. 31

Table 3. Estimated mean weight of *Parastichopus californicus* from samples collected during June 2012 – May 2013.. 34

Table 4. Biomass estimates from Open surveys conducted June 2012 – May 2013..... 36

Table 5. Linear density (sea cucumbers per meter shoreline; c/m-sh) for *Parastichopus californicus*, *Cucumaria miniata* and *C. pallida*, by transect, in the Petrel – South Principe survey. 39

Table 6. Linear density (sea cucumbers per meter shoreline; c/m-sh) for *Parastichopus californicus*, *Cucumaria miniata* and *C. pallida*, by transect, in the West Aristazabal survey 44

Table 7. Linear density (sea cucumbers per meter shoreline; c/m-sh) for *Parastichopus californicus*, *Cucumaria miniata* and *C. pallida*, by transect, in the Seaforth – Spiller Channel survey 47

Table 8. Linear density (sea cucumbers per meter shoreline; c/m-sh) for *Parastichopus californicus*, *Cucumaria miniata* and *C. pallida*, by transect, in the Joassa Channel survey 49

Table 9. Linear density (sea cucumbers per meter shoreline; c/m-sh) for *Parastichopus californicus*, *Cucumaria miniata* and *C. pallida*, by transect, in the Tribune Channel survey 51

Table 10. Linear density (sea cucumbers per meter shoreline; c/m-sh) for *Parastichopus californicus*, *Cucumaria miniata* and *C. pallida*, by transect, in the Drury Inlet survey 53

Table 11. Linear density (sea cucumbers per meter shoreline; c/m-sh) for *Parastichopus californicus*, *Cucumaria miniata* and *C. pallida*, by transect, in the Kingcome – Wakeman survey 55

Table 12. Linear density (sea cucumbers per meter shoreline; c/m-sh) for *Parastichopus californicus*, *Cucumaria miniata* and *C. pallida*, by transect, in the Quatsino Sound survey 57

LIST OF FIGURES

Figure 1. Sea cucumber surveys conducted June 2012 to May 2013. 61

Figure 2. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 5-14, surveyed as part of the Petral-South Principe survey in 2012. 62

Figure 3. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 5-14.. 63

Figure 4a-b. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 5-16, surveyed as part of the Petral-South Principe survey in 2012.. 64

Figure 5a-b. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 5-16 66

Figure 6a-b. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 5-17, surveyed as part of the Petral-South Principe survey in 2012.. 68

Figure 7a-b. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in a portion of PFMA 5-17.. 70

Figure 8a-c. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in northern portions of PFMA 6-13, surveyed as part of the West Aristazabal survey in 2012.. 72

Figure 9a-c. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 6-13 75

Figure 10. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 7-12, surveyed as part of the Seaforth-Spiller Channel survey in 2012. 78

Figure 11. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 7-12.. 79

Figure 12. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 7-13, surveyed as part of the Seaforth-Spiller Channel survey in 2012.. 80

Figure 13. Abundances of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 7-13.. 81

Figure 14a-b. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 7-22 & 7-23, surveyed as part of the Joassa Channel survey in 2012.. 82

Figure 15a-b. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 7-22 & 7-23. 84

Figure 16. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* PFMA 12-35 & 12-37, surveyed as part of the Tribune Channel survey in 2013. 86

Figure 17. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 12-35 & 12-37. 87

Figure 18. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 12-36, surveyed as part of the Tribune Channel survey in 2013. 88

Figure 19. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 12-36. 89

Figure 20. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 12-42, surveyed as part of the Drury Inlet survey in 2013.. 90

Figure 21. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 12-42.. 91

Figure 22. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 12-43, surveyed as part of the Kingcome-Wakeman survey in 2013.. 92

Figure 23. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in a portion of PFMA 12-43. 93

Figure 24. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 12-45 and 12-46, surveyed as part of the Kingcome-Wakeman survey in 2013.. 94

Figure 25. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 12-45 and 12-46. 95

Figure 26. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 12-47 and 12-48, surveyed as part of the Kingcome-Wakeman survey in 2013.. 96

Figure 27. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 12-47 and 12-48............................ 97

Figure 28. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 27-7, surveyed as part of the Quatsino Sound survey in 2013.. 98

Figure 29. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 27-7... 99

Figure 30. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 27-8, surveyed as part of the Quatsino Sound survey in 2013.. 100

Figure 31. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 27-8... 101

Figure 32. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 27-9, surveyed as part of the Quatsino Sound survey in 2013.. 102

Figure 33. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 27-9... 103

Figure 34. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 27-10, surveyed as part of the Quatsino Sound survey in 2013.. 104

Figure 35. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 27-10... 105

Figure 36a-b. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 27-11, surveyed as part of the Quatsino Sound survey in 2013.. 106

Figure 37a-b. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 27-11.. 108

ABSTRACT

Duprey, N.M.T., and Stanton, L.M. 2015. Biomass estimates for sea cucumber (*Parastichopus californicus, Cucumaria miniata, C. pallida*) as determined through surveys conducted June 2012 to May 2013. Can. Manuscr. Rep. Fish. Aquat. Sci. 3083: viii + 109p.

Stock assessment surveys of the Giant Red Sea Cucumber, *Parastichopus californicus*, population in British Columbia have been ongoing since 1998. Between June 2012 and May 2013, eight surveys were conducted to provide Fisheries Managers with population density and biomass estimates. The relative abundance of Red Sea Urchin (*Strongylocentrotus franciscanus*), Green Sea Urchin (*Strongylocentrotus droebachiensis*), and Geoduck (*Panopea generosa*) were also estimated and are presented here. The Joassa Channel, Tribune Channel, Drury Inlet, Kingcome – Wakeman, West Aristazabal, and Quatsino Sound survey results showed low sea cucumber densities with all of the Pacific Fishery Management Subareas below the respective Regional Baseline Densities (Duprey et al. 2011). The Petrel – South Principe survey and half of the Seaforth – Spiller Channel survey had higher sea cucumber densities, with Pacific Fishery Management Subareas near or above the Regional Baseline Densities (Duprey et al. 2011).

RÉSUMÉ

Duprey, N.M.T., and Stanton, L.M. 2015. Biomass estimates for sea cucumber (*Parastichopus californicus, Cucumaria miniata, C. pallida*) as determined through surveys conducted June 2012 to May 2013. Can. Manuscr. Rep. Fish. Aquat. Sci. 3083: viii + 109p.

Des relevés d'évaluation des stocks de l'holothurie rouge géante du Pacifique (*Parastichopus californicus*) en Colombie-Britannique sont effectués annuellement depuis 1998. Entre juin 2012 et mai 2013, huit relevés ont été effectués afin d'indiquer aux gestionnaires des pêches la densité de population et les estimations de la biomasse. L'abondance relative de l'oursin rouge (*Strongylocentrotus franciscanus*), de l'oursin vert (*Strongylocentrotus droebachiensis*), et de la panope (*Panopea generosa*) a également été estimée et est présentée ici. Les résultats des relevés dans le chenal Joassa, le chenal Tribune, le bras de mer Drury, Kingcome et Wakeman, Aristazabal Ouest, et la baie Quatsino, ont permis d'établir que les densités d'holothuries dans tous les sous-secteurs de gestion des pêches du Pacifique couverts étaient inférieures à la densité de référence régionale (Duprey et al. 2011). Les relevés du chenal Pétrel – chenal Principe Sud et la moitié de Seaforth – Chenal Spiller affichaient des densités d'holothuries plus élevées et tous les sous-secteurs de gestion des pêches du Pacifique affichaient des densités près ou au-dessus de la densité de référence régionale (Duprey et al. 2011).

INTRODUCTION

The fishery for Giant Red Sea Cucumber, *Parastichopus californicus* (Stimpson, 1857), in British Columbia (BC) had an annual value of approximately 7.4 million Canadian dollars in 2011 (K. Ridgway, Pacific Sea Cucumber Harvesters Association, pers. comm.). Landings were first recorded in Canada in 1971, and the fishery underwent several management changes through the 1980's and 1990's. Since 1995, the fishery has undergone a rigorous period of data collection, analysis and information review. The objective was to develop a biologically-based stock assessment program and risk-averse fishery management. The first stock assessment and quota options paper was completed in 1995, utilizing a surplus production model (Phillips and Boutillier 1998). In the course of conducting this assessment, gaps in knowledge of the species' biology were identified and shortcomings of the fishery-dependent data became clear. Phillips and Boutillier (1998) identified the need for a change in approach for the BC sea cucumber fishery and laid the groundwork for a more comprehensive, Phase 0 (*fide* Perry et al. 1999), review in 1996 (Boutillier et al. 1998). The Phase 0 review paper concluded that the fishery was not providing the information necessary for stock assessments and evaluation of the impacts of the commercial fishery on sea cucumber populations. Accordingly, it was recommended that the fishery henceforth be conducted in a manner that would provide the necessary data. Phase 1 of the sea cucumber fishery began in 1997 (Hand and Rogers 1999), wherein the area open to commercial harvest was restricted to a static 25% of the coast, 50% of the coast was closed to harvest, and the remaining 25% of the coast was set aside for experimental fishery research. Only a small fraction of the area set aside for experimental fishery research was used; therefore the closed area encompassed almost 75% of the coast. A fishery-independent survey program was initiated in areas open to commercial harvest (termed 'Open' surveys) in BC. These Open surveys are used to determine the density and biomass of sea cucumbers in a given area.

After 10-years of fisheries-dependent and -independent research conducted in the Phase 1 regime, the data collected from Open surveys, experimental fisheries and biological sampling were analyzed and the results and recommendations were presented to and accepted by the Pacific Invertebrate Subcommittee of the Canadian Science Advisory Secretariat (CSAS) in 2007 (Hand et al. 2009). The recommendation to allow re-opening of the commercial fishery beyond the geographically-restricted area of 25% of the shoreline, using BC-based exploitation rates, was endorsed. It was also recommended and approved that any re-opened areas should be surveyed prior to the occurrence of commercial harvesting (Hand et al. 2009; Duprey et al. 2011). The sea cucumber fishery then entered Phase 2, 'fishing for commerce' (Perry et al. 1999).

Prior to re-opening areas in BC to commercial harvesting, surveys were conducted to estimate the density and biomass of sea cucumbers within them. A total of 142 new Pacific Fishery Management (PFM) Subareas have been surveyed from July 2007 through May 2013, and survey results have provided site-specific estimates of sea cucumber density and biomass (Duprey 2011; Duprey 2012; Duprey 2014). The Integrated Fishery Management Plan (DFO 2014) lists all PFM Subareas currently open for commercial harvest of sea cucumber.

This manuscript report presents the results of eight Open surveys conducted between June 2012 and May 2013: two Open surveys in the North Coast region (Petrel and South Principe and West Aristazabal; Figure 1); two Open surveys in the Central Coast region (Seaforth – Spiller Channel and Joassa Channel; Figure 1); three Open surveys in the East Coast of Vancouver Island region (Tribune Channel, Drury Inlet, and Kingcome – Wakeman; Figure 1); and one Open survey on the West Coast of Vancouver Island (Quatsino Sound; Figure 1). Regional Baseline densities were calculated in Duprey et al. (2011) and were used as surrogate values for calculating biomass for un-surveyed PFM Subareas. The value of the Regional Baseline densities were based off the lowest of all the 90% LCB of the bootstrapped estimated mean from PFM Subareas within the region from 1997 to 2007. The Regional Baseline densities are as follows: North Coast = 6.0 c/m-sh; Central Coast = 6.0 c/m-sh; East Coast Vancouver Island = 4.1 c/m-sh; and West Coast Vancouver Island = 1.9 c/m-sh (Duprey et al. 2011).

In this report five of the Open surveys were in areas not open to fishing at the time of surveying (West Aristazabal, Tribune Channel, Drury Inlet, Kingcome – Wakeman, and Quatsino Sound), but were being considered for opening in upcoming harvest seasons. Three of the Open surveys were in areas open to commercial fishing at the time of the survey (Petrel and South Principe, Seaforth – Spiller Channel, and Joassa Channel). In addition, one Open survey (Trutch) was conducted in August of 2012 but, is not included within this report as it was closed in 2009, and was therefore being re-surveyed to monitor for changes in density which will require a more comprehensive report to be completed.

This report summarizes the survey protocols, describes the survey methodology, and presents the results of data analysis for density, mean weight and biomass of the *P. californicus* populations, density estimates for the *Cucumaria miniata* and *C. pallida* sea cucumber populations and relative abundance estimates of Geoducks (*Panopea generosa*), Red Sea Urchins (*Strongylocentrotus franciscanus*) and Green Sea Urchins (*S. droebachiensis*).

METHODS

Open surveys are the standard survey method used in BC to assess the *P. californicus* population (Duprey et al. 2011). They are used to assess density and biomass in areas currently open to commercial harvesting and for assessing areas that are not currently open to commercial harvesting, but where there is a desire to re-open the area in upcoming years.

OPEN SURVEY METHODS

Surveying

While each Open Survey was prepared separately, the methods used to prepare and conduct each survey were the same. Firstly, the entire shoreline of each PFM Subarea was measured using ArcGIS 9.3 (Table 1). The basemap used to measure the shoreline was the cucland.shp dataset, projected in BC Albers. Using the ArcGIS 9.3

measurements, transect locations were determined by placing one transect systematically every two kilometers along the shoreline using Xtools (see Table 1 for total number of surveyed transects by PFM Subarea).

Each transect was surveyed by two SCUBA divers. A marked leadline was placed in a perpendicular line to shore, from zero gauge depth to 15.2 m gauge depth. The leadline was marked with zapstraps and coloured electrical tape at 5 m intervals called quadrats. A buoy was anchored to the deep end of the line at approximately 15.2 m (50 ft.). Two divers descended the buoy line to this depth and began the survey. Each diver had a 2 m pole with an attached datasheet. One diver was designated as the left diver and the other, the right; each diver was responsible for counting and recording the number of sea cucumbers within each quadrat on their side of the transect line. The left diver was responsible for counting the sea cucumbers straddling the transect line. For each quadrat, the following were recorded: the number of adult and the number juvenile (sea cucumbers less than 15 cm, the size of the pencil used by divers) *P. californicus*, up to three dominant substrate types, and no more than two dominant algae types. Sea cucumbers were counted if more than half of the animal was within the quadrat. The depth of each quadrat was also recorded. One diver recorded the number of *C. miniata* and *C. pallida* observed on their side of the transect. Because the white tentacles of *C. pallida* can be confused with those of *Eupentacta* spp., some *Eupentacta* may be included in the *C. pallida* numbers presented in this report. As only one diver was recording the *Cucumaria* information, the swath covered was limited to their pole length of 2 m as compared to the 4 m wide swath covered for *P. californicus*, where both divers count animals. Relative abundance estimates of Red Sea Urchins, Green Sea Urchins and Geoducks were also recorded on the dive regardless of how far they were seen from the transect line; each transect was designated as having either None, Few (1–10), Many (11–100) or Abundant (100+) animals.

Biosampling

The average weight and weight-frequency distribution of the populations was determined from biosamples, which were small collections of *P. californicus* that were individually weighed. Biosamples were collected from predetermined transects that were randomly selected from all transect locations. Approximately one biosample was collected for every 10 transects in an Analysis Area. After these selected transects were surveyed, the divers handpicked 25 sea cucumbers from the transect line and surrounding area up to a maximum depth of 15.2 m. Juveniles were not collected during biosampling and therefore their weights were not included in biomass calculations. The animals were brought on board the boat, where they were longitudinally split, left to drain and, at the end of the day, individually weighed. A total of 55 biosamples were collected from the eight Open surveys presented in this report.

SURVEY AREA DESCRIPTIONS

The eight Open surveys described in this report were conducted from June 2012 through May 2013 between Petrel and Principe Channels in the North to Tribune Channel in the South.

Petrel – South Principe

Petrel – South Principe is located entirely within Pacific Fisheries Management Area (PFMA) 5, which is located in the North Coast region (Figure 1). This area was open to commercial sea cucumber harvesting, but had not been surveyed for sea cucumber before. The survey included three PFM Subareas, 5–14, 5–16, and 5–17 (Figures 2-7) and was conducted from August 20 – September 2, 2012 onboard a commercial fishing vessel. The survey was conducted in partnership with the Pacific Sea Cucumber Harvesters Association (PSCHA) with a contract biologist present for the 14 days of surveying.

PFM Subarea 5–14 includes Newcombe Harbour and encompasses Petrel Channel north to Strouts Point and South to Petrel Point. PFM Subarea 5–16 includes most of the small islands, inlets and bays surrounding Anger Island. The area west of Petrel Point to Foul Point and the area north of Brecker Point to the southern tip of Anger Island comprises this Subarea. PFM Subarea 5–17 captures most of the southern portion of Principe Channel; this includes the area north of a line from Deer Point to Ring Point, as far north as Headwind Point and Foul Point but excludes Patterson Inlet which is a separate PFM Subarea. The total shoreline length of all three PFM Subareas was measured as 477.0 km using ArcGIS 9.3.

West Aristazabal

The West Aristazabal Open survey was located in the PFMA 6, which is located in the North Coast of Vancouver Island region (Figure 1). This area had been closed to sea cucumber harvesting since 1998 and was surveyed for potential re-opening. The survey included one PFM Subarea, 6–13 (Figures 8 and 9) and was conducted from July 10–20, 2012 onboard the Kitasoo Fishery Research Vessel. The survey was conducted in partnership with the Kitasoo/Xai'xais First Nation's Kitasoo Fishery Program with a DFO biologist present for the 11 days of surveying.

PFM Subarea 6–13 is a large Subarea covering the entire West coast of Aristazabal Island (Figure 8). The total shoreline length of the PFM Subarea was measured as 253.8 km using ArcGIS 9.3.

Seaforth – Spiller Channel

The Seaforth – Spiller Channel Open survey was located in the PFMA 7, within the Central Coast region (Figure 1). This area was open to commercial sea cucumber harvesting, but had not been surveyed for sea cucumber before. The survey included two PFM Subareas, 7–12 and 7–13 (Figures 10-13) and was conducted from October 1–5, 2012 onboard the CCGS Vector by DFO biologists; this survey was conducted concurrently with the Joassa Channel survey.

PFM Subarea 7–12 comprises Seaforth Channel as far west as a line from Dryad Point to Ark Island (Figure 10). This Subarea includes Dearth Island but excludes Dundivan Inlet, Return Channel (from Hay Island to Noon Point) and Spiller Channel (from a point just north of Bullen Rock to Grief Island). PFM Subarea 7–13 includes the southern reach of

Spiller Channel. The northern border of the Subarea is a parallel line across the Channel eastward from Mosquito Bay (Figure 12). The total shoreline length of the two PFM Subareas was measured as 159.4 km using ArcGIS 9.3.

Joassa Channel

The Joassa Channel Open survey was located in the PFMA 7, within the Central Coast region (Figure 1). This area was open to commercial sea cucumber harvesting, but had not been surveyed for sea cucumber before. The survey included two PFM Subareas, 7–22 and 7–23 (Figures 14 and 15) and was conducted from October 1–5, 2012 onboard the CCGS Vector by DFO biologists; this survey was conducted at the same time as the Seaforth – Spiller Channel survey.

PFM Subarea 7–22 is comprised of Dundivan Inlet and Lockhart Bay and boarders PFM Subarea 7–23 at the northern end of Rait Narrows. PFM Subarea 7–23 encompasses Joassa Channel south from Rait Narrows all the way to and including Louise Channel, Boddy Narrows, Hochstader Basin, Peter Bay and the inlet south of Redford Point. The total shoreline length of the two PFM Subareas in the Joassa Channel survey was measured as 154.5 km using ArcGIS 9.3.

Tribune Channel

The Tribune Channel Open survey was located in PFMA 12, within the East Coast of Vancouver Island region (Figure 1). This area had been closed to sea cucumber harvesting since 1998 and was surveyed for potential re-opening. The survey included 3 PFM Subareas, 12–35 to 12–37 (Figures 16-19) and was conducted from February 19–22, 2013 onboard a commercial fishing vessel. The survey was conducted in partnership with the PSCHA with a DFO biologist present for the four days of surveying.

PFM Subarea 12–35 is made up of Tribune Channel, covering most of the east side of Gilford Island including Viscount Island but excluding Shewell Island. PFM Subarea 12–36 encompasses all of Thompson Sound. PFM Subarea 12–37 contains Band Sound. The total length of the shoreline in the surveyed area was measured as 168.5 km using ArcGIS 9.3.

Drury Inlet

The Drury Inlet Open survey was located in PFMA 12, within the East Coast of Vancouver Island region (Figure 1). This area had been closed to sea cucumber harvesting since 1998 and was surveyed for potential re-opening. The survey included one PFM Subarea, 12–42 (Figures 20 and 21) and was conducted from February 26–28, 2013 onboard a commercial fishing vessel. The survey was conducted in partnership with the PSCHA with a DFO biologist present for the three days of surveying.

PFM Subarea 12–42 covers all of Drury Inlet. The total length of the shoreline in the surveyed area was measured as 136.4 km using ArcGIS 9.3.

Kingcome – Wakeman

The Kingcome – Wakeman Open survey was located in PFMA 12, within the East Coast of Vancouver Island region (Figure 1). This area had been closed to sea cucumber harvesting since 1998 and was surveyed for potential re-opening. The survey included five PFM Subareas, 12–43, 12–45, 12–46, 12–47, and 12–48 (Figures 22-27) and was conducted from February 23–25, 2013 onboard a commercial fishing vessel. The survey was conducted in partnership with the PSCHA; a DFO biologist was present for the three days of surveying.

PFM Subarea 12–43 has a southern border of a line between Philip Point and Bradley Point and a northern border of a line between Frances Point and Upton Point. PFM Subarea 12–45 is comprised of Belleisle Sound and Kingcome Inlet from Frances Pont and Philadelphia Point to a line from Petley Point due south. PFM Subarea 12–46 contains the remaining part of Kingcome Inlet past Petley Point. PFM Subarea 12–47 includes the southern part of Wakeman Sound from Upton and Philadelphia Points north. PFM Subarea 12–48 encompasses the northern section of Wakeman Sound and begins north of Corsan Creek and the peak of Mount Beckford. The total length of the shoreline in the surveyed area was measured as 130.2 km using ArcGIS 9.3.

Quatsino Sound

The Quatsino Sound Open survey was located in PFMA 27, within the West Coast of Vancouver Island region (Figure 1). This area had been closed to sea cucumber harvesting since 1998 and was surveyed for potential re-opening. The survey included five PFM Subareas, 27–7 to 27–11 (Figures 28-37) and was conducted from March 13–15 and April 9–13 2013 onboard a commercial fishing vessel. The survey was conducted in partnership with the PSCHA; a contract biologist was present for the eight days of surveying.

PFM Subarea 27–7 within Quatsino Sound is comprised of the waters surrounding Koskimo Islands, Schloss Island, Salmon Islands, Brockton Island, and Drake Island and includes Nordstrom Cove, Koskimo Bay, Koprino Harbour, Bulcholz Channel and Kultus Cove. PFM Subarea 27–8 encompasses all of Neroutsos Inlet. PFM Subarea 27–9 contains the area just east of Leeson Point and Evenson Point and includes Hecate Cove, Kokwina Cove, and the Quatsino Narrows north up to Sorenson Point and Kultah Point. The entirety of Rupert Inlet and Holberg Inlet makes up the Subareas 27–10 and 27–11, respectively. The total length of the shoreline in the surveyed area was measured as 313.2 km using ArcGIS 9.3.

DATA ANALYSIS

Density estimations

For statistical analysis, the linear density of *P. californicus, C. miniata and C. pallida* was calculated for each transect by dividing the total number of sea cucumbers by the width of the transect (4 m for *P. californicus* and 2 m for *C. miniata* and *C. pallida*). On a PFM Subarea basis, the transect data were analyzed using the CukeAnalysis Program (version 2008 11 19), which calculated the mean density and confidence bounds using the bootstrapping technique (see Hand et al. [2009] for more details). Transect data were re-sampled with 1000 iterations using a random seed of 756. Some PFM Subareas were small and therefore had sample sizes too low to obtain good results from bootstrapping (a sample size of 10 transects is preferred). Analysis Areas were developed to avoid this complication: PFM Subareas in the same survey were pooled with other PFM Subareas that had similar bathymetry and geographical shape, and analyzed as one (see Table 1 for a list of Analysis Areas). The mean *P. californicus, C. miniata and C. pallida* density, and 75%, 90%, 95%, 99% confidence bounds from the bootstrap were calculated for each Subarea or Analysis Area.

Mean weight estimations

Biosamples were used to estimate mean animal weight within each PFM Subarea. Each sea cucumber collected in a biosample was weighed individually. The individual weights within a biosample (approximately 25 sea cucumbers) were averaged to produce a mean biosample weight for the sampled transect. The PFM Subarea's mean weight was the mean of all the biosample averages collected from transects within that Subarea (Duprey et al. 2011). If no biosamples were collected within a PFM Subarea then the lowest mean weight estimate of all of the Subareas within the same survey was used (Duprey et al. 2011).

Biomass estimations

The biomass of *P. californicus* in a PFM Subarea was estimated at various confidence bounds (CB) using the following formula

$$\text{Biomass}_{CB} = [(\text{Shoreline}_{Protected}*\text{Density}_{CB})*\text{Wt}_{mean}] + [(\text{Shoreline}_{Exposed}*2.5)*\text{Wt}_{mean}]$$

where Density_{CB} is the density from the bootstrap output and Wt_{mean} is the mean individual sea cucumber weight attributed to the Subarea from biosampling (Duprey et al. 2011). The shoreline length used to calculate biomass was measured using the GIS software Compugrid and is currently housed in the DFO Fisheries Management database. $\text{Shoreline}_{exposed}$ is the cumulative shoreline in a Subarea that has been designated exposed in the BC Shorezone dataset (Hand et al. 2009; Duprey et al. 2011). $\text{Shoreline}_{protected}$ is the cumulative shoreline in a Subarea that has been designated Semi-Exposed to Very Protected (Duprey et al. 2011). If the Density_{CB} value is lower than 2.50 sea cucumbers per metre of shoreline (c/m-sh), then ($\text{Shoreline}_{Exposed}$*2.5) is replaced with the [($\text{Shoreline}_{Exposed}$*$\text{Density}_{CB}$). See Duprey et al. (2011) for a detailed description of methods used to calculate biomass estimates.

RESULTS

DENSITY SURVEYS

The following sections describe the results and analyses of mean linear *Parastichopus californicus* densities, estimated mean weight of biosamples, and biomass estimations for each PFM Subarea (Tables 2-4). Linear density estimates of *P. californicus, C. miniata,* and *C. pallida* for all transects within the eight Open surveys conducted are listed in Tables 5 to 12. A figure was developed for each PFM Subarea, indicating the position of a transect and providing scaled symbols for density ranges of *P. californicus*. The density ranges represented by the bubble size and colour in the figures differ by Analysis Areas, and were chosen for their relevance to stock assessment benchmarks as follows. There are as many as five categories of density ranges in each figure. Absence of sea cucumbers (0.0 sea cucumbers/metre of shoreline (c/m-sh)) and up to 2.49 c/m-sh are used in every figure. Zero was chosen as a category to aid in determining areas where no sea cucumbers were observed. The next category range of 0.01 to 2.49 c/m-sh was chosen because a 90% lower confidence bound (LCB) of 2.50 c/m-sh, for an Analysis Area, is noted as an important threshold value in Duprey et al. (2011). The remaining three category ranges differ depending on the survey location and the results of the analysis. The third density range is between 2.50 c/m-sh and either the regional baseline density or the 90% LCB of the bootstrapped transect densities, whichever is lower. Baseline densities are densities attributed to un-surveyed open areas within a region, as follows: North Coast = 6.0 c/m-sh; Central Coast = 6.0 c/m-sh; East Coast Vancouver Island = 4.1 c/m-sh; and West Coast Vancouver Island = 1.9 c/m-sh (Duprey et al. 2011). The forth density range is from the regional baseline density to the 90% LCB, or vice versa depending on which is lower. If the maximum estimated density is low, the upper end of the forth range is the maximum observed density in the Analysis Area. The final range in the figures is from the 90% LCB (or regional baseline density) to the maximum density estimated in the Analysis Area. If the maximum estimated density is less than the baseline density then this category is not present.

PFMA 5–14 (Petrel – South Principe)

Parastichopus californicus

PFM Subarea 5–14 had a variety of low and high densities observed throughout the Subarea (Figure 2). Lower densities of *P. californicus* were observed in the northern portion of Petrel Channel and higher densities were observed within the southern sections. A total of 29 of the 45 transects surveyed had a density of 6.00 c/m-sh or less (Table 5). The highest transect density observed was 31.50 c/m-sh and the lowest 0.0 c/m-sh.

The DFO Fisheries Management database had a total shoreline length for Subarea 5–14 of 89,880 m, of which 1,857 m was classified as Exposed and 88,023 m classified as Protected by the BC Shorezone classification system. Two transects were not surveyed (transect 221 due to unmanageable currents and transect 201 as it was in non-navigable waters), therefore 4,000 m of shoreline was removed from the total shoreline length to represent this area. The total shoreline length used for biomass calculations was 84,023 m of Protected shoreline and 1,857 m of Exposed shoreline.

Mean sea cucumber density was estimated to be 6.5 c/m-sh and the 90% LCB of the bootstrap was 4.9 c/m-sh (Table 2). An average weight was calculated from each of the five biosamples (transects 191, 206, 213, 220, and 234; Table 3); the Subarea mean of these five values was 259 g (Table 3). Using the corrected shoreline length, average weight and the 90% LCB of the bootstrapped density the biomass estimate was 107,836 kg (Table 4).

Cucumaria miniata and *C. pallida*

C. miniata and *C. pallida* numbers were not recorded on the Petrel – South Principe survey.

Geoduck, Green Sea Urchin and Red Sea Urchin abundance

Relative abundance data were collected from all of the 45 transects surveyed in PFM Subarea 5–14. 'Few' Geoducks were observed on 6 (13%) transects, 'Many' were observed on 3 (7%) transects, 'Abundant' Geoducks were observed on 2 (4%) transects while no Geoducks were observed on the remaining 34 (76%) transects (Figure 3).

'Few' Green Sea Urchins were observed on 8 (18%) transects, 'Many' were observed on 1 (2%) transect, 'Abundant' numbers were observed on 1 (2%) transect and Green Sea Urchins were not observed on 35 (78%) transects (Figure 3). 'Few' Red Sea Urchins were observed on 10 (22%) transects, 'Many' were observed on 11 (24%) transects, 'Abundant' Red Sea Urchins were observed on 14 (31%) transects while no Red Sea Urchins were observed on the remaining 10 (22%) transects (Figure 3).

PFMA 5–16 (Petrel – South Principe)

Parastichopus californicus

PFM Subarea 5–16 had the highest densities of *P. californicus* of all the Petrel – South Principe Subareas with high densities of *P. californicus* scattered throughout the Subarea (Figures 4a and 4b). A total of 42 of the 100 transects surveyed had a density of 6.00 c/m-sh or less (Table 5). The highest density observed was 46.00 c/m-sh and the lowest density observed was 0.0 c/m-sh.

The DFO Fisheries Management database had a total shoreline length for Subarea 5–16 of 199,080 m, of which 745 m was classified as Exposed and 198,335 m classified as Protected by the BC Shorezone classification system. Five transects (163–167) were not surveyed due to their location at the back of Anger Inlet which was not accessible. Therefore, 10,000 m of shoreline was removed from the total shoreline length to represent this non-navigable area. The total shoreline length used for biomass calculations was 188,335 m of Protected shoreline and 745 m of Exposed shoreline.

Mean sea cucumber density was estimated to be 8.9 c/m-sh and the 90% LCB of the bootstrap was 7.9 c/m-sh (Table 2). An average weight was calculated from each of the ten biosamples (transects 86, 103, 107, 118, 126, 140, 145, 168, 175 and 185; Table 3); the Subarea mean of these ten values was 310 g (Table 3). Using the corrected shoreline length, average weight and the 90% LCB of the bootstrapped density the biomass estimate for PFMA 5–16 was 461,810 kg (Table 4).

Cucumaria miniata and *C. pallida*

C. miniata and *C. pallida* numbers were not recorded on the Petrel – South Principe survey.

Geoduck, Green Sea Urchin and Red Sea Urchin abundance

Relative abundance data for Geoduck were collected from 99 of the 100 transects surveyed in PFM Subarea 5–16. 'Few' Geoducks were observed on 6 (6%) transects, 'Many' were observed on 3 (3%) transects while no Geoducks were observed on the remaining 90 (91%) transects (Figures 5a and 5b).

Relative abundance data for sea urchins were collected from all of the 100 transects surveyed in Subarea 5–16. 'Few' Green Sea Urchins were observed on 5 (5%) transects, 'Many' were observed on 1 (1%) transect, 'Abundant' Green Sea Urchins were observed on 1 (1%) transect and zero on the remaining 93 (93%) transects (Figures 5a and 5b). 'Few' Red Sea Urchins were observed on 31 (31%) transects, 'Many' were observed on 11 (11%) transects, 'Abundant' were observed on 14 (14%) transects and 44 (44%) transects had none observed (Figures 5a and 5b).

PFMA 5–17 (Petrel – South Principe)

Parastichopus californicus

PFM Subarea 5–17 had mostly higher density transects scattered throughout the Subarea with highly variable *P. californicus* densities (Figures 6a, b, and c). A total of 47 of the 80 transects surveyed had a density of 6.00 c/m-sh or less (Table 5). The highest density observed was 32.75 c/m-sh and the lowest density observed was 0.25 c/m-sh.

The DFO Fisheries Management database had a total length for Subarea 5–17 of 173,645 m, all of which was classified as Protected by the BC Shorezone classification system. Four transects (22, 23, 24, 31) were not surveyed due to being in non-navigable waters in Buchan Inlet and Lundy Cove. Therefore 8,000 m of shoreline was removed from the total shoreline length to represent this non-navigable area. The total shoreline length used for biomass calculations was 165,645 m of Protected shoreline.

Mean sea cucumber density was estimated to be 6.9 c/m-sh and the 90% LCB of the bootstrap was 5.8 c/m-sh (Table 2). An average weight was calculated from each of the six biosamples (transects 8, 20, 37, 52, 64, and 79; Table 3); the Subarea mean of these six values was 270 g (Table 3). Using the corrected shoreline length, average weight and the 90% LCB of the bootstrapped density the biomass estimate was 259,400 kg (Table 4).

Cucumaria miniata and *C. pallida*

Cucumaria miniata and *C. pallida* numbers were not recorded on the Petrel – South Principe survey.

Geoduck, Green Sea Urchin and Red Sea Urchin abundance

Relative abundance data were collected from all 80 transects surveyed in PFM Subarea 5–17. 'Few' Geoducks were observed on 7 (9%) transects, 'Many' were observed on 4 (5%) transects, 'Abundant' were observed on 5 (6%) transects and zero Geoducks were observed on the remaining 64 (80%) transects (Figures 7a, b, c).

'Few' Green Sea Urchins were observed on 23 (29%) transects, 'Many' were observed on 3 (4%) transects, 'Abundant' numbers were observed on 2 (2%) transects and none were observed on the remaining 52 (65%) transects surveyed (Figures 7a, b, c). 'Few' Red Sea Urchins were observed on 14 (18%) transects, 'Many' were observed on 24 (30%) transects, 'Abundant' numbers were observed on 31 (39%) transects and none were observed on the remaining 11 (14%) transects surveyed (Figures 7a, b, c).

PFMA 6–13 (West Aristazabal)

Parastichopus californicus

PFM Subarea 6–13, had highly variable *P. californicus* densities throughout the Subarea (Figures 8a, b, c). Eighty-six of the 116 transects surveyed had a density of less than 6.0 c/m-sh (Table 6). The highest density observed was 25.00 c/m-sh and the lowest density observed was 0 c/m-sh.

The DFO Fisheries Management database had a total length for PFM Subarea 6–13 of 312,144 m, of which 19,326 m was classified as Exposed and 291,218 m classified as Protected by the BC Shorezone classification system. The West Aristazabal survey did not include Weeteeam Bay and all shoreline southeast of the Arriaga Islands; this area totalled 69,700 m and was removed from biomass calculations. Eleven transects were not surveyed in the remainder of the Subarea (transects 35, 46, 50, 68, 69, 80, 85, 99, 115, 116, and 117). As a result, 22,000 m of shoreline was removed to represent these unsurveyed areas. The total shoreline length used for biomass calculations after the removal of unsurveyed shoreline lengths was 19,326 m classified as Exposed and 199,518 m classified as Protected.

Mean sea cucumber density was estimated to be 3.9 c/m-sh and the 90% LCB of the bootstrap was 3.2 c/m-sh (Table 2). An average weight was calculated from each of the seven biosamples (transects 2, 17, 61, 74, 100, 113 and 123; Table 3); the Subarea mean of these seven values was 259 g (Table 3). Using the corrected shoreline length, average weight and the 90% LCB of the bootstrapped density the biomass estimate was 177,874 kg (Table 4).

Cucumaria miniata and *C. pallida*

C. miniata and *C. pallida* numbers were recorded on all of the 116 transects surveyed in the Subarea. *C. miniata* were not observed on 25 of the 116 transects surveyed, and the highest density observed was 108 c/m-sh (Table 6). The mean density was estimated to be 18.6 c/m-sh with a 90% LCB of 15.1 c/m-sh. Using the entire shoreline length of PFM Subarea 6–13 and the 90% LCB of the density, the estimated population of *C. miniata* was 3,304,544 sea cucumbers.

C. pallida were not observed on 91 of the 116 transects surveyed, and the highest density observed was 16.5 c/m-sh (Table 6). The mean density was estimated to be 0.63 c/m-sh with a 90% LCB of 0.4 c/m-sh. Using the entire shoreline length of PFM Subarea 6–13 and the 90% LCB of the density, the estimated population of *C. pallida* was 87,537 sea cucumbers.

Geoduck, Green Sea Urchin and Red Sea Urchin abundance

Relative abundance of Geoducks were collected on 108 of the 116 transects surveyed in PFM Subarea 6–13. 'Few' were observed on 10 (9%) transects, 'Many' on 14 (13%) transects, 'Abundant' on 10 (9%) transects and none were observed on the remaining 74 (69%) transects (Figure 9a, b, c).

Relative abundance data for Green Sea Urchins were collected on 110 of the 116 transects surveyed in Subarea 6–13. No Green Sea Urchins were observed on 87 (75%) of the surveyed transects in the Subarea, 'Few' were observed on 17 (15%) transects, 'Many' were observed on 5 (5%) transects and 1 (1%) transect was observed as having 'Abundant' Green Sea Urchins (Figures 9a, b, c). Relative abundance of Red Sea Urchins were collected on 111 of the 116 transects surveyed in Subarea 6–13. 'Abundant' Red Sea Urchins were observed on 67 (60%) transects, 'Many' were observed on 16 (14%) transects, 'Few' were observed on 6 (5%) transects and none were observed on 22 (20%) transects (Figures 9a, b, c).

PFMA 7–12 (Seaforth – Spiller Channel)

Parastichopus californicus

PFM Subarea 7–12 had a mixture of high and low densities with most of the higher densities of *P. californicus* observed in the eastern section of the Channel/Subarea (Figure 10). A total of 21 of the 43 transects had a density of 6.0 c/m-sh or less (Table 7). The highest density observed was 40.00 c/m-sh and four transects had 0 c/m-sh.

No Shoreline segments were removed due to logistical obstacles or other closures. The DFO Fisheries Management database has a total length for PFM Subarea 7–12 of 83,194 m, of which 1,204 m is classified as Exposed and 81,990 m classified as Protected by the BC Shorezone classification system.

Mean sea cucumber density was estimated to be 7.9 c/m-sh with a 90% LCB of 6.2 c/m-sh (Table 2). An average weight was calculated from each of the four biosamples (transects 86, 92, 100, and 116; Table 3); the Subarea mean of these four values was 252 g (Table 3). The 90% LCB of the mean biomass estimate was 128,860 kg (Table 4).

Cucumaria miniata and *C. pallida*

C. miniata and *C. pallida* data were recorded on all 43 transects surveyed in the Subarea. No *C. miniata* were observed on 21 of the 43 transects surveyed, and the highest density observed was 78.0 c/m-sh (Table 7). The mean density was estimated to be 9.2 c/m-sh with a 90% LCB of 5.6 c/m-sh. Using a shoreline length of 83,194 m for PFM Subarea 7–12 and the 90% LCB of the density, the estimated population of *C. miniata* was 465,887 sea cucumbers.

No *C. pallida* were observed on 26 of the 45 transects surveyed, and the highest density observed was 30.5 c/m-sh (Table 7). The mean density was estimated to be 2.2 c/m-sh with a 90% LCB of 1.3 c/m-sh. Using a shoreline length of 83,194 m for PFM Subarea 7–12 and the 90% LCB of the density, the estimated population of *C. pallida* was 108,153 sea cucumbers.

Geoduck, Green Sea Urchin and Red Sea Urchin abundance

Relative abundance data were collected on all 43 transects surveyed in PFM Subarea 7–12. 'Few' Geoducks were observed on 5 (12%) transects, 'Many' were observed on 8 (19%) transects, 'Abundant' were observed on 8 (19%) transects and none were observed on 22 (51%) transects (Figure 11).

'Few' Green Sea Urchins were observed on 15 (35%) transects, 'Many' were observed on 14 (32%) transect, 'Abundant' Green Sea Urchins were observed on 2 (5%) transects and none were observed on 12 (28%) transect. 'Few' Red Sea Urchins were observed on 18 (42%) transects, 'Many' were observed on 10 (23%) transects, 'Abundant' numbers were observed on 1 (2%) transect and none were observed on 14 (32%) transects (Figure 11).

PFMA 7–13 (Seaforth – Spiller Channel)

Parastichopus californicus

PFM Subarea 7–13 had a variety of high and low *P. californicus* densities throughout the Subarea. Higher *P. californicus* densities were observed on the eastern side of the Subarea and in the southern sections of the channel near Yeo Cove and Early Passage (Figure 12). A total of 27 of the 35 transects surveyed had a density of less than 6.0 c/m-sh. The highest density observed was 24.00 c/m-sh and the lowest density observed was 0.00 c/m-sh (Table 7).

The DFO Fisheries Management database has a total length for Subarea 7–13 of 61,233 m, all of which was classified as Protected by the BC Shorezone classification system. One transects was not surveyed due to its location in non-navigable waters far up the Tankeeah River. Thus, 2,000 m of shoreline was removed from the total shoreline length to represent this area. Therefore, the total shoreline length used for biomass calculations was 59,233 m of Protected shoreline.

Mean sea cucumber density was estimated to be 4.3 c/m-sh with a 90% LCB of 3.0 c/m-sh (Table 2). An average weight was calculated from each of the four biosamples (transects 128, 133, 143 and 153; Table 3); the Subarea mean of these four values was 320 g (Table 3). The 90% LCB of the mean biomass estimate was 56,864 kg (Table 4).

Cucumaria miniata and *C. pallida*

C. miniata and *C. pallida* numbers were recorded on all 35 transects surveyed in the Subarea. No *C. miniata* were observed on 12 of the 35 transects surveyed, and the highest density observed was 34.0 c/m-sh (Table 7). The mean density was estimated to be 3.9 c/m-sh with a 90% LCB of 2.2 c/m-sh. Using the corrected shoreline length of 59,233 m and the 90% LCB of the density, the estimated population of *C. miniata* was 130,313 sea cucumbers.

No *C. pallida* were observed on 6 of the 35 transects surveyed (Table 7). The mean density was estimated to be 10.1 c/m-sh with a 90% LCB of 6.3 c/m-sh. Using the corrected shoreline length of 59,233 m and the 90% LCB of the density, the estimated population of *C. pallida* was 373,168 sea cucumbers.

Geoduck, Green Sea Urchin and Red Sea Urchin abundance

Relative abundance data were collected from all 35 transects surveyed in PFM Subarea 7–13. 'Few' Geoducks were observed on 4 (11%) transects, 'Many' were observed on 8 (23%) transect, 'Abundant' were observed on 2 (6%) transects and none were observed on 21 (60%) transects (Figure 13).

'Few' Green Sea Urchins were observed on 10 (29%) transects, 'Many' were observed on 5 (14%) transect, 'Abundant' were observed on 1 (3%) transect and none were observed on 19 (54%) transects. 'Few' Red Sea Urchins were observed on 9 (26%) transects, 'Many' were observed on 5 (14%) transects, 'Abundant' were observed on 1 (3%) transect and none were observed on 20 (57%) transects (Figure 13).

PFMA 7–22 and 7–23 (Joassa Channel)

Parastichopus californicus

The transects within PFM Subareas 7–22 and 7–23 were analyzed together as one Analysis Area and were combined for the bootstrap analysis; 7 and 67 transects were surveyed in each area, respectively. Overall, Joassa Channel had variable *P. californicus* densities throughout both subareas, with higher densities observed within the smaller 7-22 Subarea around Dundivan Inlet and Lockhart Bay (Figures 14a, b). The lowest linear densities of *P. californicus* observed in the seven transects within the smaller 7-22 subarea was 2.25 c/m-sh and five out of the seven transects had densities greater than 2.5 c/m-sh. A total of 65 of the 74 transects surveyed, within the two Subareas, had a density of less than 6.0 c/m-sh (Table 8). The highest density observed was 11.50 c/m-sh and the lowest was 0 c/m-sh.

In PFM Subarea 7–22 no shoreline segments were removed due to logistical obstacles or other closures. The DFO Fisheries Management database has a total length for PFM Subarea 7–22 of 12,818 m all classified as Protected by the BC Shorezone classification system. The DFO Fisheries Management database has a total length for PFM Subarea 7–23 of 192,461 m, of which 850 m is classified as Exposed and 191,611 m classified as Protected by the BC Shorezone classification system. However, measuring the shoreline length using ArcGIS has indicated a likely error in the original measurement in the DFO management database. Therefore the shoreline length for PFM Subarea 7–23 is reduced to the ArcGIS measured length of 140,200 m, of which we have classified 850 m as Exposed and the remaining 139,350 as Protected. Three transects were not surveyed in PFM Subarea 7–23 due to non-navigable waters, therefore a total of 6,000 m of shoreline was removed from the total shoreline length to represent these non-navigable areas. Therefore, the total shoreline length used for biomass calculations was 850 m of Exposed and 133,350 m of Protected shoreline.

Mean sea cucumber density for the Analysis Area was estimated to be 2.6 c/m-sh with a 90% LCB of 2.1 c/m-sh (Table 2). PFM Subarea 7–22 had an average weight calculated for the one biosample (transects 77; Table 3); the Subarea mean was 332 g (Table 3).

PFM Subarea 7–23 had an average weight calculated for each of the six biosamples (transects 14, 26, 29, 52, 54, and 62; Table 3); the Subarea mean of these six values was 314 g (Table 3). The 90% LCB of the mean biomass estimate was 8,937 kg for PFM Subarea 7–22 and was 88,491 kg for PFM Subarea 7–23 (Table 4).

Cucumaria miniata and *C. pallida*

C. miniata and *C. pallida* numbers were recorded on all 74 transects surveyed in the PFM Subareas. No *C. miniata* were observed on 49 of the 74 transects surveyed had and the highest density observed was 31.0 c/m-sh (Table 8). The mean density was estimated to be 1.3 c/m-sh with a 90% LCB of 0.6 c/m-sh. Using the corrected shoreline lengths of each PFM Subarea and the 90% LCB of the density, the estimated population of *C. miniata* was 7,691 and 80,520 sea cucumbers in Subarea 7–22 and 7–23, respectively.

No *C. pallida* were observed on 39 of the 74 transects surveyed, and the highest density observed was 12.5 c/m-sh (Table 8). The mean density was estimated to be 1.2 c/m-sh with a 90% lower confidence bound of 0.9 c/m-sh. Using the corrected shoreline lengths of each PFM Subarea and the 90% LCB of the density, the estimated population of *C. pallida* was 11,537 and 120,780 sea cucumbers in Subarea 7–22 and Subarea 7–23, respectively.

Geoduck, Green Sea Urchin and Red Sea Urchin abundance

Relative abundance data were collected from 72 of the 74 transects surveyed in PFM Subareas 7–22 and 7–23. 'Few' Geoducks were observed on 6 (8%) transects, 'Many' on 5 (7%) transects, and zero on the remaining 61 (85%) transects (Figures 15a, b).

'Few' Green Sea Urchins were observed on 21 (29%) transects, 'Many' on 12 (17%) transects, 'Abundant' were observed on 8 (11%) transects and zero on the remaining 31 (43%) transects (Figures 15a, b). 'Few' Red Sea Urchins were observed on 21 (29%) transects, 'Many' on 4 (5%) transects and none on the remaining 47 (65%) transects (Figures 15a, b).

PFMA 12–35 and 12–37 (Tribune Channel)

Parastichopus californicus

The transects within PFM Subareas 12–35 and 12–37 were analyzed together as one Analysis Area and were combined for the bootstrap analysis; 67 and 7 transects were surveyed in each area, respectively. Overall, both Subareas had a variety of both high and low *P. californicus* densities throughout (Figure 16). A total of 54 of the 74 transects surveyed had a density of less than 4.1 c/m-sh (Table 9). The highest density observed was 17.25 c/m-sh and the lowest density observed was 0.00 c/m-sh.

No shoreline segments were removed due to logistical obstacles or other closures. The DFO Fisheries Management database has a total length for PFM Subarea 12–35 of 118,138 m all of which is classified as Protected by the BC Shorezone classification system. The DFO Fisheries Management database has a total length for PFM Subarea

12–37 of 11,844 m all of which is classified as Protected by the BC Shorezone classification system.

Mean sea cucumber density for the Analysis Area was estimated to be 3.1 c/m-sh with a 90% LCB of 2.5 c/m-sh (Table 2). PFM Subarea 12–35 had an average weight calculated for each of the six biosamples (transects 7, 17, 30, 47, 60, and 74; Table 3); the Subarea mean of these six values was 193 g (Table 3). PFM Subarea 12–37 had an average weight calculated for the one biosample (transects 21; Table 3); the Subarea mean was 162 g (Table 3). The 90% LCB of the mean biomass estimate was 57,002 kg for PFM Subarea 12–35 and was 4,797 kg for PFM Subarea 12–37 (Table 4).

Cucumaria miniata and *C. pallida*

C. miniata and *C. pallida* data were recorded on 25 of the 67 transects surveyed in PFM Subarea 12–35 and all of the 7 transects surveyed in PFM Subarea 12–37. No *C. miniata* were observed on 26 of the 32 transects surveyed, and the highest density observed was 4.5 c/m-sh (Table 9). The mean density was estimated to be 0.6 c/m-sh with a 90% LCB of 0.3 c/m-sh. Using the corrected shoreline length of PFM Subarea 12–35 and the total shoreline length of PFM Subarea 12–37 and the 90% LCB of the density, the estimated population of *C. miniata* was 10,242 and 3,554 sea cucumbers in each PFM Subarea, respectively.

No *C. pallida* were observed on any of the 32 transects surveyed (Table 9). The mean density was therefore 0.0 c/m-sh with a 90% LCB of 0.0 c/m-sh. Using the corrected shoreline length and the 90% LCB of the density, the estimated population of *C. pallida* was 0 sea cucumbers for both PFM Subareas 12–35 and 12–37.

Geoduck, Green Sea Urchin and Red Sea Urchin abundance

Relative abundance data were collected all of the 74 transects surveyed in PFM Subareas 12–35 and 12–37. 'Many' Geoducks were observed on 1 (1%) transect and none were observed on the remaining 73 (99%) transects (Figure 17).

'Few' Green Sea Urchins were observed on 18 (24%) transects 'Many' were observed on 11 (15%) transects, 'Abundant' on 25 (34%) transects and none on the remaining 20 (27%) transects (Figure 17). 'Few' Red Sea Urchins were observed on 4 (5%) transects, and none on the remaining 70 (95%) transects (Figure 17).

PFMA 12–36 (Tribune Channel)

Parastichopus californicus

PFMA 12–36 had low *P. californicus* densities throughout the Subarea within Thompson Sound (Figure 18). A total of 10 of the 11 transects surveyed had a density of less than 4.1 c/m-sh (Table 9). The highest density observed was 5.25 c/m-sh and the lowest density observed was 0 c/m-sh.

No shoreline segments were removed due to logistical obstacles or other closures. The *DFO Fisheries Management database has a total length for Subarea 12–36 of 17,002 m,* all of which is classified as Protected by the BC Shorezone classification system.

Mean sea cucumber density was estimated to be 0.9 c/m-sh with a 90% LCB of 0.4 c/m-sh (Table 2). An average weight was calculated for the one biosamples (transect 81; Table 3); the Subarea mean was 380 g (Table 3). The 90% LCB of the mean biomass estimate was 2,584 kg (Table 4).

Cucumaria miniata and *C. pallida*

C. miniata and *C. pallida* data were recorded on all 11 transects surveyed in the PFM Subarea. No *C. miniata* were observed on 8 of the 11 transects surveyed (Table 9). The mean density was estimated to be 1.0 c/m-sh with a 90% LCB of 0.1 c/m-sh. Using the total shoreline length and the 90% LCB as the estimated density, the estimated population of *C. miniata* was 1,700 sea cucumbers.

No *C. pallida* were observed on 10 of the 11 transects surveyed, and the only density observed was 0.5 c/m-sh (Table 9). The mean density was estimated to be 0.0 c/m-sh with a 90% LCB of 0.0 c/m-sh. Using the total shoreline length and the 90% LCB as the estimated density, the estimated population of *C. pallida* was 0 sea cucumbers.

Geoduck, Green Sea Urchin and Red Sea Urchin abundance

Relative abundance data were collected on all 11 transects surveyed in PFM Subarea 12–36. No Geoducks were observed on the 11 transects (Figure 19).

'Few' Green Sea Urchins were observed on 3 (27%) transects, 'Many' were observed on 4 (36%) transects, 'Abundant' were observed on 2 (18%) transects and none on the remaining 2 (18%) transects (Figure 19). No Red Sea Urchins were observed in the PFM Subarea (Figure 19).

PFMA 12–42 (Drury Inlet)

Parastichopus californicus

In PFM Subarea 12–42, on the western side of Drury Inlet, few to no *P. californicus* were observed on transects (Figure 20). Higher density transects were observed along the eastern end of Drury Inlet within Stuart Narrows. A total of 50 of the 56 transects surveyed had a density of less than 4.1 c/m-sh (Table 10). The highest density observed was 39.00 c/m-sh and the lowest density observed was 0.00 c/m-sh.

The DFO Fisheries Management database has a total length for Subarea 12–42 of 132,602 m all of which is classified as Protected by the BC Shorezone classification system. Twelve transects were not surveyed; 7 of the 12 unsurveyed transects were located in inaccessible areas (Tsibass Lagoon and Sutherland Bay; transects 25, 37-42), the other 5 transects were not surveyed due to extremely poor visibility in Actaeon Sound and heavy currents in Actress Passage (transects 30, 31, 35, 36, 44). A total of 24,000 m of shoreline was removed from the total shoreline length to represent these areas.

Therefore, the total shoreline length used for biomass calculations was 108,602 m of Protected shoreline.

Mean sea cucumber density was estimated to be 2.2 c/m-sh with a 90% LCB of 1.1 c/m-sh (Table 2). An average weight was calculated for the singular biosample collected (transects 3; Table 3); the Subarea mean of was 193 g (Table 3). The 90% LCB of the mean biomass estimate was 23,056 kg (Table 4).

Cucumaria miniata and *C. pallida*

C. miniata and *C. pallida* data were recorded on all 56 transects surveyed in the PFM Subarea. No *C. miniata* were observed on 53 of the 56 transects surveyed (Table 10). The mean density was 0.1 c/m-sh with a 90% LCB of 0.0 c/m-sh. Using the corrected shoreline length of Subarea 12–42 and the 90% LCB of the density, the estimated population of *C. miniata* was 0 sea cucumbers.

C. pallida were not observed on any of the 56 transects surveyed (Table 10). The mean density was therefore 0.0 c/m-sh with a 90% LCB of 0.0 c/m-sh. Using the corrected shoreline length of the PFM Subarea and the 90% LCB of the density, the estimated population of *C. pallida* was 0 sea cucumbers.

Geoduck, Green Sea Urchin and Red Sea Urchin abundance

Relative abundance data were collected on all of the 56 transects surveyed in PFM Subarea 12–42. Geoducks were not observed on any transects in the PFM Subarea (Figure 21).

'Few' Green Sea Urchins were observed on 3 (5%) transects, 'Many' on 1 (2%) transect, 'Abundant' Green Sea Urchins on 2 (4%) transects and none on the remaining 50 (89%) transects (Figure 21). 'Few' Red Sea Urchins were observed on 1 (2%) transect and none on the remaining 55 (98%) transects.

PFMA 12–43 (Kingcome – Wakeman)

Parastichopus californicus

PFM Subarea 12–43 had consistently low densities of *P. californicus* throughout the Subarea (Figure 22). All 20 transects surveyed had a density of less than 4.1 c/m-sh (Table 11). The highest density observed was 3.50 c/m-sh and the lowest density observed was 0.00 c/m-sh.

No shoreline segments were removed due to logistical obstacles or other closures. The DFO Fisheries Management database has a total length for Subarea 12–43 of 32,642 m all of which is classified as Protected by the BC Shorezone classification system.

Mean sea cucumber density was estimated to be 1.0 c/m-sh with a 90% LCB of 0.5 c/m-sh (Table 2). An average weight was calculated from each of the two biosamples (transects 3 and 11; Table 3); the Subarea mean of these two values was 203 g (Table 3). The 90% LCB of the mean biomass estimate was 3,313 kg (Table 4).

Cucumaria miniata and *C. pallida*

C. miniata and *C. pallida* data were recorded on 10 of the 20 transects surveyed in the Subarea. No *C. miniata* were observed on 9 of the 10 transects surveyed, and the highest density observed was 2.5 c/m-sh (Table 11). The mean density was estimated to be 0.2 c/m-sh with a 90% LCB of 0.0 c/m-sh. Using the total shoreline length of Subarea 12–43 and the 90% LCB of the density, the estimated population of *C. miniata* was 0 sea cucumbers.

C. pallida were not observed on any of the 10 transects surveyed (Table 11). The mean density was therefore 0.0 c/m-sh with a 90% LCB of 0.0 c/m-sh. Using the total shoreline length of Subarea 12–43 and the 90% LCB of the density, the estimated population of *C. pallida* was 0 sea cucumbers.

Geoduck, Green Sea Urchin and Red Sea Urchin abundance

Relative abundance data were collected on all of the 20 transects surveyed in PFM Subarea 12–43. Geoducks were not observed on any transects in the PFM Subarea (Figure 23).

'Few' Green Sea Urchins were observed on 6 (30%) transects, 'Many' were observed on 8 (40%) transects, 'Abundant' Green Sea Urchins on 3 (15%) transects and none on the remaining 3 (15%) transects (Figure 23). Red Sea Urchins were not observed on any transects in the PFM Subarea (Figure 23).

PFMA 12–45 and 12–46 (Kingcome – Wakeman)

Parastichopus californicus

The transects within PFM Subareas 12–45 and 12–46 were analyzed together as one Analysis Area, 28 and 5 transects were surveyed in each Subarea, respectively. PFM Subarea 12–45 had low *P. californicus* densities overall, however, higher densities were observed in Belleisle Sound, whereas no *P. californicus* were observed in PFM Subarea 12–46 (Figure 24). Thirty of the 33 transects surveyed had a density of less than 4.1 c/m-sh (Table 11). The highest density observed was 6.5 c/m-sh and the lowest was 0.00 c/m-sh.

The DFO Fisheries Management database has a total length for Subarea 12–45 of 52,668 m, all of which is classified as Protected by the BC Shorezone classification system. One of the plotted transects, transect 40, was not surveyed in PFM Subarea 12–45. As a result 2,000 m of shoreline were removed from the total shoreline length to represent this area. Therefore, the total shoreline length used for biomass calculations was 50,668 m of Protected shoreline for PFM Subarea 12-45. The DFO Fisheries Management database has a total length for Subarea 12–46 of 7,325 m; 4,238 m of which is classified as Exposed and 3,086 m of which is classified as Protected by the BC Shorezone classification system.

Mean sea cucumber density for the Analysis Area was estimated to be 1.0 c/m-sh with a 90% LCB of 0.6 c/m-sh (Table 2). No biosamples were collected in Subareas 12–45 or 12–46; therefore the lowest PFM Subarea mean weight from the Kingcome – Wakeman survey, 203 g, was used for biomass calculations (Duprey *et al.* 2011). The 90% LCB of the mean biomass estimate for PFM Subareas 12–45 and 12–46 was 6,171 kg and 892 kg, respectively (Table 4).

Cucumaria miniata and *C. pallida*

C. miniata and *C. pallida* data were recorded on all 33 transects surveyed in the PFM Subareas. No *C. miniata* were observed on any of the 33 transects surveyed (Table 11). The mean density was therefore 0.0 c/m-sh with a 90% LCB of 0.0 c/m-sh. Using the shoreline lengths for the two PFM Subareas and the 90% LCB of the density, the estimated population of *C. miniata* was 0 sea cucumbers for both PFM Subareas.

No *C. pallida* were observed on 32 of the 33 transects surveyed, and the highest density observed was 2.0 c/m-sh (Table 11). The mean density was estimated to be 0.1 c/m-sh with a 90% LCB of 0.0 c/m-sh. Using the total shoreline length for the two PFM Subareas and the 90% LCB of the density, the estimated population of *C. pallida* was 0 sea cucumbers in both PFM Subareas.

Geoduck, Green Sea Urchin and Red Sea Urchin abundance

Relative abundance data were collected on all 33 transects surveyed in the two PFM Subareas. Geoducks were not observed on any transects in the PFM Subareas (Figure 25).

'Few' Green Sea Urchins were observed on 5 (15%) transects, 'Many' on 6 (18%) transects, 'Abundant' numbers were observed on 4 (12%) transects, and no Green Sea Urchins were observed on the remaining 18 (55%) transects (Figure 25). No Red Sea Urchins were observed on the 33 transects surveyed (Figure 25).

PFMA 12–47 and 12–48 (Kingcome – Wakeman)

Parastichopus californicus

The transects within PFM Subareas 12–47 and 12–48, making up Wakeman Sound, were analyzed together as one Analysis Area with 7 and 6 transects surveyed in each Subarea, respectively. PFM Subarea 12–47 and 12-48 had low *P. californicus* densities throughout however, slightly higher densities were observed in PFM Subarea 12-47 compared to PFM Subarea 12-48 (Figure 26). All of the 13 transects surveyed had a density of less than 4.1 c/m-sh (Table 11). The highest density observed was 2.75 c/m-sh and the lowest density observed was 0.00 c/m-sh.

No shoreline segments were removed due to logistical obstacles or other closures. The DFO Fisheries Management database has a total length for Subarea 12–47 of 17,590 m; all of which is classified as Protected by the BC Shorezone classification system. The DFO Fisheries Management database has a total length for Subarea 12–48 of 7,308 m; 1,545 m of which is classified as Exposed and 5,763 m of which is classified as Protected by the BC Shorezone classification system.

Mean sea cucumber density for the Analysis Area was estimated to be 0.7 c/m-sh with a 90% LCB of 0.2 c/m-sh (Table 2). No biosamples were collected in Subareas 12–47 or

12–48; therefore the lowest PFM Subarea mean weight from the Kingcome – Wakeman survey, 203 g, was used for biomass calculations (Duprey *et al.* 2011). The 90% LCB of the mean biomass estimate for PFM Subareas 12–47 and 12–48 was 714 kg and 297 kg, respectively (Table 4).

Cucumaria miniata and *C. pallida*

C. miniata and *C. pallida* data were recorded on 9 of the 13 transects surveyed in the PFM Subareas. Neither *C. miniata,* nor *C. pallida*, were observed on any of the 9 transects surveyed (Table 11). A minimum of 10 transects need to be surveyed before a bootstrap analysis is run, however as no *Cucumaria* were seen in the PFM Subareas the estimated populations were 0 sea cucumbers for both PFM Subareas.

Geoduck, Green Sea Urchin and Red Sea Urchin abundance

Relative abundance data were collected on all 13 transects surveyed in the two PFM Subareas. Geoducks were not observed on any transects in the PFM Subareas (Figure 27).

'Few' Green Sea Urchins were observed on 1 (8%) transect, 'Many' on 6 (46%) transects, 'Abundant' on 1 (8%) transects and zero on the remaining 5 (38%) transects (Figure 27). Red Sea Urchins were not observed on any transects in the PFM Subareas (Figure 27).

PFMA 27–7 (Quatsino Sound)

Parastichopus californicus

PFM Subarea 27–7 had relatively low *P. californicus* densities throughout, but exhibited the highest densities of all the Quatsino Sound Subareas (Figure 28). All of the 53 transects surveyed had a density less than 4.1 c/m-sh (Table 12). The highest density observed was 4.00 c/m-sh and the lowest was 0.00 c/m-sh.

The DFO Fisheries Management database has a total length for Subarea 27–7 of 99,658 m; 292 m of which is classified as Exposed and 99,366 m of which is classified as Protected by the BC Shorezone classification system. Two of the plotted transects were not surveyed (transects 1 and 50); as a result 4,000 m of shoreline were removed from the total shoreline length to represent this area. Therefore, the total shoreline length used for biomass calculations was 292 m Exposed and 95,366 m of Protected shoreline.

Mean sea cucumber density was estimated to be 0.2 c/m-sh with a 90% LCB of 0.1 c/m-sh (Table 2). An average weight was calculated for the one biosample collected (transect 24; Table 3); the Subarea mean was 303 g (Table 3). The 90% LCB of the mean biomass estimate was 2,898 kg for Subarea 27–7 (Table 4).

Cucumaria miniata and *C. pallida*

C. miniata and *C. pallida* data were recorded on 44 of the 53 transects surveyed in the PFM Subarea. No *C. miniata* were observed on 25 of the 53 transects surveyed, and the highest density observed was 31.5 c/m-sh (Table 12). The mean density was estimated to be 1.4 c/m-sh with a 90% LCB of 0.6 c/m-sh. Using the corrected shoreline length of Subarea 27–7 and the 90% LCB of the density, the estimated population of *C. miniata* was 46,595 sea cucumbers.

No *C. pallida* were observed on 18 of the 44 transects surveyed and the highest density observed was 52.0 c/m-sh (Table 12). The mean density was estimated to be 6.8 c/m-sh with a 90% LCB of 4.1 c/m-sh. Using the corrected shoreline length of Subarea 27–7and the 90% LCB of the density, the estimated population of *C. pallida* was 318,398 sea cucumbers.

Geoduck, Green Sea Urchin and Red Sea Urchin abundance

Relative abundance data were collected on all of the 53 transects surveyed in PFM Subareas 27–7. 'Many' Geoducks were observed on 1 (2%) transect and the remaining 52 (98%) transects had no Geoducks observed (Figure 29).

'Few' Green Sea Urchins were observed on 1 (2%) transect and none on 52 (98%) transects (Figure 29). Red Sea Urchins were not observed on any transects in the PFM Subarea (Figure 29).

PFMA 27–8 (Quatsino Sound)

Parastichopus californicus

PFM Subareas 27–8, making up Neroutsos Inlet, had consistently low or no *P. californicus* densities throughout the Subarea, with only three transects having densities greater than 0.24 c/m-sh (Figure 30). All of the 31 transects surveyed had a density of less than 4.1 c/m-sh and 28 transects had no *P. californicus* observed (Table 12). The highest density observed was 1.00 c/m-sh and the lowest density observed was 0.00 c/m-sh.

The DFO Fisheries Management database has a total length for Subarea 27–8 of 67,402 m; 2,694 m of which is classified as Exposed and 64,708 m of which is classified as Protected by the BC Shorezone classification system. Two of the plotted transects were not surveyed (transect 82 and 86); as a result 4,000 m of shoreline was removed from the total shoreline length to represent this area. Therefore, the total shoreline length used for Subarea 27–8 biomass calculations was 2,694 m of Exposed and 60,708 m of Protected shoreline.

Mean sea cucumber density was estimated to be 0.0 c/m-sh with a 90% LCB of 0.0 c/m-sh (Table 2). No biosamples were collected in Subarea 27–8; therefore the lowest PFM Subarea mean weight from the Quatsino Sound survey, 303 g, was used for biomass calculations (Duprey *et al.* 2011). The 90% LCB of the mean biomass estimate was 0 kg for Subarea 27–7 (Table 4).

Cucumaria miniata and *C. pallida*

C. miniata and *C. pallida* data were recorded on 22 of the 31 transects surveyed in the Subarea. No *C. miniata* were observed on 20 of the 22 transects surveyed, and the highest density observed was 3.0 c/m-sh (Table 12). The mean density was estimated to be 0.2 c/m-sh with a 90% LCB of 0.0 c/m-sh. Using the corrected shoreline length of the PFM Subareas and the 90% LCB of the density, the estimated population of *C. miniata* was 0 sea cucumbers.

No *C. pallida* were observed on 18 of the 22 transects surveyed (Table 12). The mean density was estimated to be 0.8 c/m-sh with a 90% LCB of 0.2 c/m-sh. Using the corrected shoreline length of the PFM Subarea and the 90% LCB of the density, the estimated population of *C. pallida* was 9,081 sea cucumbers.

Geoduck, Green Sea Urchin and Red Sea Urchin abundance

Relative abundance data were collected on all of the 31 transects surveyed in PFM Subarea. No Geoducks, Green Sea Urchins or Red Sea Urchins were observed on any transects surveyed in the Subarea (Figure 31).

PFMA 27–9 (Quatsino Sound)

Parastichopus californicus

PFM Subarea 27–9 had consistently low *P. californicus* densities throughout the Subarea (Figure 32). A total of 11 of the 12 transects surveyed had a density of less than 4.1 c/m-sh and 8 transects had a density of 0 c/m-sh (Table 12). The highest density observed was 4.50 c/m-she and the lowest density observed was 0.00 c/m-sh.

The DFO Fisheries Management database has a total length for Subarea 27–9 of 21,689 m all classified as Protected by the BC Shore zone classification system. One of the plotted transects was not surveyed (transect 100); as a result 2,000 m of shoreline were removed from the total shoreline length to represent this area. Therefore, the total shoreline length used for biomass calculations was 19,689 m of protected shoreline.

Mean sea cucumber density was estimated to be 0.5 c/m-she with a 90% LCB of 0.1 c/m-she (Table 2). No bio samples were collected in Subarea 27–9; therefore the lowest PFM Subarea mean weight from the Quatsino Sound survey, 303 g, was used for biomass calculations (Duprey *et al.* 2011). The 90% LCB of the mean biomass estimate was 597 kg for Subarea 27–9 (Table 4).

Cucumaria miniata and *C. pallida*

C. miniata and *C. pallida* data were recorded on 11 of the 12 transects surveyed in the PFM Subarea. No *C. miniata* were observed on four of the 11 transects surveyed (Table 12). The mean density was estimated to be 3.4 c/m-she with a 90% LCB of 0.3 c/m-sh. Using the corrected shoreline length of the PFM Subarea and the 90% LCB of the density, the estimated population of *C. miniata* was 5,307 sea cucumbers.

No *C. pallida* were observed on four of the 11 transects surveyed had (Table 12). The mean density was estimated to be 1.0 c/m-she with a 90% LCB of 0.5 c/m-sh. Using the corrected shoreline length and the 90% LCB of the density, the estimated population of *C. pallida* was 8,845 sea cucumbers.

Geoduck, Green Sea Urchin and Red Sea Urchin abundance

Relative abundance data were collected on all of the 31 transects surveyed in PFM Subarea. No Geoduck, Green Sea Urchins or Red Sea Urchins were observed on any transects surveyed in the Subarea (Figure 33).

PFMA 27–10 (Quatsino Sound)

Parastichopus californicus

PFM Subarea 27–10, mostly comprised of Rupert Inlet, had consistently low or no *P. californicus* densities throughout the Subarea (Figure 34). All transects surveyed had a density of less than 4.1 c/m-she and 10 of the 12 transects had a density of 0 c/m-sh (Table 12). The highest density observed was 0.50 c/m-sh and the lowest was 0.00 c/m-sh.

The DFO Fisheries Management database has a total length for Subarea 27–10 of 23,789 m; 1,138 m of which is classified as Exposed and 22,651 m of which is classified as Protected by the BC Shorezone classification system. Two of the plotted transects were not surveyed (transect 113 and 114); as a result 4,000 m of shoreline were removed from the total shoreline length to represent this area. Therefore, the total shoreline length used for biomass calculations was 1,138 m of Exposed and 18,651 m of Protected shoreline.

Mean sea cucumber density was estimated to be 0.1 c/m-sh with a 90% LCB of 0.0 c/m-sh (Table 2). No biosamples were collected in Subarea 27–10; therefore the lowest PFM Subarea mean weight from the Quatsino Sound survey, 303 g, was used for biomass calculations (Duprey *et al.* 2011). The 90% LCB of the mean biomass estimate was 0 kg for Subarea 27–10 (Table 4).

Cucumaria miniata and *C. pallida*

C. miniata and *C. pallida* data were recorded on all 12 transects surveyed in the PFM Subarea. Neither C. miniata, nor *C. pallida* were observed on any of the 12 transects surveyed (Table 12). Therefore, the mean density for both species was 0.0 c/m-sh with a 90% LCB of 0.0 c/m-sh. Using the corrected shoreline length of Subarea 27–10 and the 90% LCB of the density, the estimated population for both species was 0 sea cucumbers.

Geoduck, Green Sea Urchin and Red Sea Urchin abundance

Relative abundance data were collected on all of the 12 transects surveyed in PFM Subarea. No Geoducks, Green Sea Urchins or Red Sea Urchins were observed on any transects surveyed in the Subarea (Figure 35).

PFMA 27–11 (Quatsino Sound)

Parastichopus californicus

PFMA 27–11, Holberg Inlet, had extremely low or no *P. californicus* densities throughout the Subarea (Figure 36). All of the 42 transects surveyed had a density of less than 4.1 c/m-sh and 38 transects in the Subarea had a density of 0 c/m-sh (Table 12). The highest density observed was 0.50 c/m-sh and the lowest density observed was 0.00 c/m-sh.

The DFO Fisheries Management database has a total length for Subarea 27–11 of 83,446 m; 2,430 m of which is classified as Exposed and 81,016 m of which is classified as Protected by the BC Shorezone classification system (Table 4). One of the plotted transects was not surveyed (transect 140); as a result 2,000 m of shoreline were removed from the total shoreline length to represent this area. Therefore, the total shoreline length used for biomass calculations was 2,430 m of Exposed and 79,016 m of Protected shoreline.

Mean sea cucumber density was estimated to be 0.0 c/m-sh with a 90% LCB of 0.0 c/m-sh (Table 2). No biosamples were collected in Subarea 27–7; therefore the lowest PFM Subarea mean weight from the Quatsino Sound survey, 303 g, was used for biomass calculations (Duprey *et al.* 2011). The 90% LCB of the mean biomass estimate was 0 kg (Table 4).

Cucumaria miniata and *C. pallida*

C. miniata and *C. pallida* data were recorded on 33 of the 42 transects surveyed in the PFM Subarea. No *C. miniata* were observed on 32 of the 33 transects surveyed in Subarea 27-11 (Table 12). The mean density was estimated to be 0.0 c/m-sh with a 90% LCB of 0.0 c/m-sh. Using the corrected shoreline length of Subarea 27–11 and the 90% LCB of the density, the estimated population of *C. miniata* was 0 individuals.

No *C. pallida* were observed on the 33 transects surveyed (Table 12). Therefore, the mean density was 0.0 c/m-sh with a 90% LCB of 0.0 c/m-sh. Using the corrected shoreline length of Subarea 27–11 and the 90% LCB of the density, the estimated population of *C. pallida* was 0 sea cucumbers.

Geoduck, Green Sea Urchin and Red Sea Urchin abundance

Relative abundance data were collected on all of the 33 transects surveyed in PFM Subarea 27–11. 'Few' Geoducks were observed on 1 (3%) transect and 32 (97%) transects had no Geoducks observed (Figure 37).

No, Green Sea Urchins or Red Sea Urchins were observed on any transects surveyed in the PFM Subarea (Figure 37).

DISCUSSION

Results of the surveys presented in this report are discussed in relation to recommendations in the sea cucumber assessment framework (Duprey et al. 2011). These recommendations include: using the 90% LCB of the estimated mean density and the most location specific mean weight estimate available when estimating biomass. Also results are discussed in relation to the Regional Baseline densities calculated in Duprey et al. (2011): North Coast = 6.0 c/m-sh; Central Coast = 6.0 c/m-sh; East Coast Vancouver Island = 4.1 c/m-sh; and West Coast Vancouver Island = 1.9 c/m-sh.

Petrel – South Principe

All three PFM Subareas in the Petrel – South Principe survey had been open during phase 1 of the commercial fishery (1997-present). All three PFM Subareas in the survey had *P. californicus* bootstrapped 90% LCB density estimates higher than 2.50 c/m-sh. Two of the PFM Subareas, 5–14 and 5–17, had *P. californicus* bootstrapped 90% LCB density estimates below the Regional Baseline Densities of 6.0 c/m-sh for the North Coast, while one PFM Subarea 5–16 had a *P. californicus* bootstrapped 90% LCB density estimate above the Regional Baseline Densities of 6.0 c/m-sh for the North Coast.

West Aristazabal

The estimated density of *P. californicus* in the West Aristazabal Survey had a bootstrapped 90% LCB above 2.50 c/m-sh. However, the PFM Subarea's bootstrapped LCB was below the Regional Baseline calculated for the Central Coast of 6.0 c/m-sh (Duprey et al. 2011). It should be noted that a large portion of the Subarea, Weeteeam Bay, was not included in the survey and consequently was not used in the biomass calculation.

Seaforth – Spiller Channel

Both PFM Subareas in the Seaforth – Spiller Channel survey had been open during phase 1 of the commercial fishery (1997-present). The bootstrapped 90% LCB of the estimated density of *P. californicus* for both PFM Subareas 7–12 and 7–13 were higher than 2.50 c/m-sh. The bootstrapped 90% LCB of the estimated density of *P. californicus* in Subarea 7–12 was slightly above the Regional Baseline Density of 6.0 c/m-sh for the Central Coast (Duprey et al. 2011). However, the bootstrapped 90% LCB of the estimated density of *P. californicus* in Subarea 7–13 was half of the Regional Baseline Density (6.0 c/m-sh) for the Central Coast.

Joassa Channel

Both PFM Subareas in the Joassa Channel survey had been open during phase 1 of the commercial fishery (1997-present). The estimated densities of *P. californicus* for the Joassa Channel Survey indicated overall low densities. The two Subareas were combined for analysis, due to the small sample size in Subarea 7–22. The bootstrapped 90% LCB density estimate for the combined area was below 2.50 c/m-sh and was therefore also below the Central Coast Regional Baseline density of 6.0 c/m-sh (Duprey et al. 2011). However, it should be noted that Subarea 7–22 had higher transect densities than those observed in Subarea 7–23.

Tribune Channel

The survey results for the Tribune Channel survey indicated marginal densities, overall. The density estimates of *P. californicus* for Subarea 12–36 were below 2.50 c/m-sh. Densities in Subarea 12–35 and 12–37, which were combined during analysis, had a bootstrapped 90% LCB estimated density of exactly 2.50 c/m-sh. All three were therefore below the East Coast of Vancouver Island Regional Baseline density of 4.1 c/m-sh (Duprey et al. 2011).

Drury Inlet

The bootstrapped 90% LCB estimated density of *P. californicus* within PFM Subarea 12–42 was below 2.50 c/m-sh and was therefore also below the East Coast of Vancouver Island Regional Baseline density of 4.1 c/m-sh (Duprey et al. 2011).

Kingcome – Wakeman

The density estimates of *P. californicus* for the Kingcome – Wakeman survey indicated low densities, overall. None of the five Subareas reached bootstrapped 90% LCB estimated densities of 2.50 c/m-sh and were therefore also below the East Coast of Vancouver Island Regional Baseline density of 4.1 c/m-sh (Duprey et al. 2011). All of the five Subareas had bootstrapped 90% LCBs below 0.7 c/m-sh.

Quatsino Sound

The estimated densities of *P. californicus* in the Quatsino Sound survey were low throughout all of the PFM Subareas surveyed. None of the five Subareas had bootstrapped 90% LCB estimated densities that reached 2.50 c/m-sh and were also below the West Coast of Vancouver Island Regional Baseline density of 1.9 c/m-sh (Duprey et al. 2011). All of the six PFM Subareas had bootstrapped 90% LCBs of 0.1 c/m-sh or less.

ACKNOWLEDGEMENTS

Many vessels and crew contributed to collecting the data presented in this report and their efforts and dedication is much appreciated. Thank-you to the many divers and skippers who were active in collecting data on the 8 surveys; Ernie Mason, Ken Cripps, Stewart Humchitt, Dan Curtis, Jessica Finney, Dan Leus, Seaton Taylor, Mike Atkins, Dominique Bureau, Rafal Kalus, Mike Boyd, Steve Acciaroli, Ralph Rey, Thomas Egli, Kenny Ridgway Jr.

Most surveys were conducted through a close partnership with the Pacific Sea Cucumber Harvesting Association; much of this work would not have been possible without their continued financial and logistical support. The West Aristazabal survey was conducted in partnership with the Kitasoo Fisheries Program. This manuscript was improved by the review and comments by Sharon Jeffery.

LITERATURE CITED

Boutillier, J.A., Campbell, A., Harbo, R., and Neifer, S. 1998. Scientific advice for management of the sea cucumber (*Parastichopus californicus*) fishery in British Columbia. P. 309-340. *In*: G.E. Gillespie and L.C. Walters [eds.]. Invertebrate Working Papers reviewed by the Pacific Stock Assessment Review Committee (PSARC) in 1996. Canadian Technical Report on Fisheries and Aquatic Sciences 2221. (http://www.dfo-mpo.gc.ca/Library/230784.pdf) (Last accessed 31 August, 2015).

DFO. 2014. Sea cucumber By Dive. October 1 2014 to September 30 2015 Integrated Fishery Management Plan. (http://www.dfo-mpo.gc.ca/Library/356289.pdf) (Last accessed 31 August, 2015).

Duprey, N.M.T. 2011. Sea Cucumber biomass estimations from surveys completed June 2009 to May 2010. Can. Manuscr. Rep. Fish. Aquat. Sci. 2954: viii + 97p. (http://www.dfo-mpo.gc.ca/Library/344269.pdf) (Last accessed 31 August, 2015).

Duprey, N.M.T. 2012. Sea Cucumber biomass estimations from surveys completed June 2010 to May 2011. Can. Manuscr. Rep. Fish. Aquat. Sci. 2960: xi + 150p. (http://www.dfo-mpo.gc.ca/Library/346266.pdf) (Last accessed 31 August, 2015).

Duprey, N.M.T. 2014. Biomass estimates for sea cucumber (*Parastichopus californicus, Cucumaria miniata, C. pallida*) as determined through surveys conducted June 2011 to May 2012. Can. Manuscr. Rep. Fish. Aquat. Sci. 3017: xi + 155p. (http://www.dfo-mpo.gc.ca/Library/355478.pdf) (Last accessed 31 August, 2015).

Duprey, N.M.T., Hand, C.M., Lochead, J., and Hajas, W. 2011. Assessment framework for sea cucumber (*Parastichopus californicus*) in British Columbia. Canadian Science Advisory Secretariat Research Document 2010/105. (http://www.dfo-mpo.gc.ca/csas-sccs/Publications/ResDocs-DocRech/2010/2010_105-eng.html) (Last accessed 31 August, 2015).

Hand, C.M., Hajas, W., Duprey, N., Lochead, J., Deault, J., and Caldwell, J. 2009. An evaluation of fishery and research data collected during the Phase 1 sea cucumber fishery in British Columbia 1998 to 2007. Canadian Science Advisory Secretariat Research Document 2008/065. (http://www.dfo-mpo.gc.ca/csas-sccs/publications/resdocs-docrech/2008/2008_065-eng.htm) (Last accessed 31 August, 2015).

Hand, C.M. and Rogers, J. 1999. Sea Cucumber Phase 1 fishery progress report. Canadian Stock Assessment Secretariat Research Document 1999/141 (http://www.dfo-mpo.gc.ca/csas-sccs/publications/resdocs-docrech/1999/1999_141-eng.htm) (Last accessed 31 August, 2015).

Perry, R.I., Walters, C.J., and Boutillier, J.A. 1999. A framework for providing scientific advice for the management of new and developing invertebrate fisheries. Reviews in Fish Biology and Fisheries **9**:125–150

Phillips, A.C and Boutillier, J.A. 1998. Stock assessment and quota options for the sea cucumber fishery. P. 147-167. *In*: B.J. Waddell, G.E. Gillespie and L.C. Walthers [eds.]. Invertebrate Working Papers reviewed by the Pacific Stock Assessment Review Committee (PSARC) in 1995. Part 2. Echinoderms. Canadian Technical Report of Fisheries and Aquatic Sciences 2215. (http://www.dfo-mpo.gc.ca/Library/235572.pdf) (Last accessed 31 August, 2015).

Table 1. Total number and ID of transects surveyed, and number of *Parastichopus californicus* biosamples collected in Open surveys conducted June 2012 – May 2013, by Pacific Fishery Management (PFM) Subarea. The total shoreline length is measured from the cucland.shp dataset using ArcGIS 9.3. (Note this is different from the shoreline length used for biomass calculations, which was measured using Compugrid.)

Analysis Areas	Survey	PFM Subareas	Shoreline Length (Km)	Number (and ID) of Transects	Biomsamples
1	Petrel – South Principe	5–14	96.4	45 (TR 190–236)	5
2	Petrel – South Principe	5–16	209.0	100 (TR 85–189)	10
3	Petrel – South Principe	5–17	171.6	80 (TR 1–84)	6
4	West Aristazabal	6–13	253.8	116 (TR 1–127)	7
5	Seaforth – Spiller Channel	7–12	86.0	43 (TR 78–120)	4
6	Seaforth – Spiller Channel	7–13	73.4	35 (TR 121–156)	4
7	Joassa Channel	7–22	14.3	7 (TR 71–77)	1
	Joassa Channel	7–23	140.2	67 (TR 1–70)	6
8	Tribune Channel	12–35	133.0	67 (TR 1–17; 25–74)	6
	Tribune Channel	12–37	13.8	7 (TR 18–24)	1
9	Tribune Channel	12–36	21.7	11 (TR 75–85)	1
10	Drury Inlet	12–42	136.4	56 (TR 1–68)	1
11	Kingcome – Wakeman	12–45	57.9	28 (TR 34–52; 58–67)	0
	Kingcome – Wakeman	12–46	8.7	5 (TR 53–57)	0
12	Kingcome – Wakeman	12–47	13.4	7 (TR 21–23; 30–33)	0
	Kingcome – Wakeman	12–48	11.5	6 (TR 24–29)	0
13	Kingcome – Wakeman	12–43	38.7	20 (TR 1–20)	2
14	Quatsino Sound	27–7	108.4	53 (TR 1–55)	1
15	Quatsino Sound	27–8	65.8	31 (TR 56–88)	0
16	Quatsino Sound	27–9	24.8	12 (TR 89–101)	0
17	Quatsino Sound	27–10	28.7	12 (TR 102–115)	0
18	Quatsino Sound	27–11	85.5	42 (TR 116–158)	0
	Total	**22**	**1793.0**	**850**	**55**

Table 2. Mean linear *Parastichopus californicus* density estimates by PFM Subarea, with lower (LCB) and upper (UCB) confidence bounds (sea cucumbers per metre of shoreline: c/m-sh) from Open surveys completed June 2012 – May 2013. Each PFM Subarea was analyzed separately except those shown with *, **, †, or ‡ which indicates that the transects were pooled into Analysis Areas.

PFM Subarea	Survey	No. Transects	Mean	Confidence Level	LCB	UCB
5–14	Petrel and South Principe	45	6.5	99	4.1	10.5
				95	4.7	9.2
				90	4.9	8.6
				75	5.3	7.9
5–16	Petrel and South Principe	100	8.9	99	7.4	11.2
				95	7.7	10.6
				90	7.9	10.4
				75	8.2	9.9
5–17	Petrel and South Principe	80	6.9	99	5.3	9.2
				95	5.7	8.5
				90	5.8	8.2
				75	6.2	7.8
6–13	West Aristazabal	116	3.9	99	2.9	5.6
				95	3.0	5.0
				90	3.2	4.8
				75	3.4	4.5
7–12	Seaforth and Spiller Channel	43	7.9	99	5.3	11.8
				95	5.9	10.9
				90	6.2	10.5
				75	6.7	9.6
7–13	Seaforth and Spiller Channel	35	4.3	99	2.5	7.4
				95	2.8	6.7
				90	3.0	6.4
				75	3.4	5.7
7–22*	Joassa Channel	74	2.6	99	1.8	3.6
				95	2.0	3.3
				90	2.1	3.2
				75	2.2	3.0
7–23*	Joassa Channel	74	2.6	99	1.8	3.6
				95	2.0	3.3
				90	2.1	3.2
				75	2.2	3.0
12–35**	Tribune Channel	74	3.1	99	2.2	4.4
				95	2.4	4.0
				90	2.5	3.8
				75	2.6	3.6

Table 2, cont'd.

PFM Subarea	Survey	No. Transects	Mean	Confidence Level	LCB	UCB
12–36	Tribune Channel	11	0.9	99	0.2	2.5
				95	0.3	2.4
				90	0.4	2.2
				75	0.5	1.7
12–37**	Tribune Channel	74	3.1	99	2.2	4.4
				95	2.4	4.0
				90	2.5	3.8
				75	2.6	3.6
12–42	Drury Inlet	56	2.2	99	0.7	5.3
				95	1.0	5.0
				90	1.1	4.4
				75	1.3	3.5
12–43	Kingcome – Wakeman	20	1.0	99	0.4	1.8
				95	0.5	1.6
				90	0.5	1.5
				75	0.7	1.3
12–45†	Kingcome – Wakeman	33	1.0	99	0.4	2.1
				95	0.5	1.8
				90	0.6	1.6
				75	0.7	1.4
12–46†	Kingcome – Wakeman	33	1.0	99	0.4	2.1
				95	0.5	1.8
				90	0.6	1.6
				75	0.7	1.4
12–47‡	Kingcome – Wakeman	13	0.7	99	0.1	1.5
				95	0.2	1.2
				90	0.2	1.1
				75	0.3	1.0
12–48‡	Kingcome – Wakeman	13	0.7	99	0.1	1.5
				95	0.2	1.2
				90	0.2	1.1
				75	0.3	1.0
27–7	Quastino Sound	53	0.2	99	0.1	0.5
				95	0.1	0.5
				90	0.1	0.4
				75	0.1	0.4

Table 2, cont'd.

PFMA Subarea	Survey	No. Transects	Mean	Confidence Level	LCB	UCB
27–8	Quastino Sound	31	0.0	99	0.0	0.2
				95	0.0	0.1
				90	0.0	0.1
				75	0.0	0.1
27–9	Quastino Sound	12	0.5	99	0.0	2.1
				95	0.0	1.8
				90	0.1	1.4
				75	0.2	1.1
27–10	Quastino Sound	12	0.1	99	0.0	0.2
				95	0.0	0.2
				90	0.0	0.1
				75	0.0	0.1
27–11	Quastino Sound	42	0.0	99	0.0	0.1
				95	0.0	0.1
				90	0.0	0.1
				75	0.0	0.0

Table 3. Estimated mean weight of *Parastichopus californicus* from samples collected during June 2012 – May 2013. The Subarea mean weight estimate is the mean of the transect averages, and is used for biomass calculations (Duprey et al. 2011).

PFMA Subarea	Survey	Transect no.	Average (g)	SD	Subarea mean (g)
5–14	Petrel and South Principe	191	230.0	61.64	259
5–14	Petrel and South Principe	206	243.5	76.37	
5–14	Petrel and South Principe	213	270.5	61.97	
5–14	Petrel and South Principe	220	242.4	88.94	
5–14	Petrel and South Principe	234	310.8	74.88	
5–16	Petrel and South Principe	86	318.9	84.84	310
5–16	Petrel and South Principe	103	373.0	92.63	
5–16	Petrel and South Principe	107	411.4	131.58	
5–16	Petrel and South Principe	118	273.8	51.45	
5–16	Petrel and South Principe	126	223.4	40.55	
5–16	Petrel and South Principe	140	261.0	76.35	
5–16	Petrel and South Principe	145	241.8	72.26	
5–16	Petrel and South Principe	168	273.7	71.13	
5–16	Petrel and South Principe	175	438.0	145.58	
5–16	Petrel and South Principe	185	281.8	53.79	
5–17	Petrel and South Principe	8	290.9	67.29	270
5–17	Petrel and South Principe	20	279.1	79.69	
5–17	Petrel and South Principe	37	314.4	60.61	
5–17	Petrel and South Principe	52	302.1	108.03	
5–17	Petrel and South Principe	64	203.6	90.78	
5–17	Petrel and South Principe	79	232.5	88.53	
6–13	West Aristazabal	2	233.7	80.44	259
6–13	West Aristazabal	17	179.8	64.65	
6–13	West Aristazabal	61	367.3	161.26	
6–13	West Aristazabal	74	201.3	54.92	
6–13	West Aristazabal	100	252.4	59.98	
6–13	West Aristazabal	113	306.0	83.72	
6–13	West Aristazabal	123	275.4	49.36	
7–12	Seaforth and Spiller Channel	86	291.5	75.17	252
7–12	Seaforth and Spiller Channel	92	234.7	43.69	
7–12	Seaforth and Spiller Channel	100	224.4	64.91	
7–12	Seaforth and Spiller Channel	116	255.7	98.00	
7–13	Seaforth and Spiller Channel	128	243.4	70.58	320
7–13	Seaforth and Spiller Channel	133	326.8	87.81	
7–13	Seaforth and Spiller Channel	143	355.5	81.88	
7–13	Seaforth and Spiller Channel	153	355.9	114.98	
7–22	Joassa Channel	77	332.2	89.10	332

Table 3, cont'd.

PFMA Subarea	Survey	Transect no.	Average (g)	SD	Subarea mean (g)
7–23	Joassa Channel	14	209.9	81.64	314
7–23	Joassa Channel	26	288.9	128.61	
7–23	Joassa Channel	29	305.8	58.15	
7–23	Joassa Channel	52	413.3	99.46	
7–23	Joassa Channel	54	400.5	115.76	
7–23	Joassa Channel	62	265.1	73.66	
12–35	Tribune Channel	7	197.7	63.41	193
12–35	Tribune Channel	17	106.6	40.83	
12–35	Tribune Channel	30	319.3	63.67	
12–35	Tribune Channel	47	211.7	45.86	
12–35	Tribune Channel	60	169.5	37.73	
12–35	Tribune Channel	74	152.9	58.49	
12–36	Tribune Channel	81	379.7	80.59	380
12–37	Tribune Channel	21	162.0	39.16	162
12–42	Drury Inlet	3	192.7	78.09	193
12–43	Kingcome – Wakeman	3	203.7	78.53	203
12–43	Kingcome – Wakeman	11	201.3	66.21	
27–7	Quatsino Sound	24	303.2	94.38	303

Table 4. Biomass estimates from Open surveys conducted June 2012 – May 2013. Biosamples were not collected from all Subareas; the lowest Wt_{mean} in the same survey was used as Wt_{mean} for Subareas marked with a * (Duprey et al. 2011).

PFMA	Survey	Shoreline Length - exposed	Shoreline Length - protected	Confidence Level	Biomass (kg) LCB	Biomass (kg) UCB
5–14	Petrel and South Principe	1,857	84,023	99	90,426	229,703
				95	103,484	201,412
				90	107,836	188,355
				75	116,541	173,122
5–16	Petrel and South Principe	745	188,335	99	432,618	654,476
				95	450,133	619,446
				90	461,810	607,769
				75	479,325	578,577
5–17	Petrel and South Principe	0	165,645	99	237,038	411,462
				95	254,928	380,155
				90	259,400	366,738
				75	277,290	348,848
6–13	West Aristazabal	19,326	199,518	99	162,372	301,894
				95	167,539	270,889
				90	177,874	260,554
				75	188,209	245,052
7–12	Seaforth and Spiller Channel	1,204	81,990	99	110,264	244,564
				95	122,661	225,969
				90	128,860	217,704
				75	139,190	199,109
7–13	Seaforth and Spiller Channel	0	59,233	99	47,386	140,264
				95	53,073	126,996
				90	56,864	121,309
				75	64,446	108,041
7–22	Joassa Channel	0	12,818	99	7,660	15,320
				95	8,511	14,043
				90	8,937	13,618
				75	9,362	12,767
7–23	Joassa Channel	850	133,350	99	75,850	151,406
				95	84,278	138,845
				90	88,491	134,657
				75	92,705	126,283
12–35	Tribune Channel	0	118,138	99	50,161	100,323
				95	54,722	91,203
				90	57,002	86,642
				75	59,282	82,082
12–36	Tribune Channel	0	17,002	99	1,292	16,152
				95	1,938	15,506
				90	2,584	14,214
				75	3,230	10,983

Table 4, cont'd.

PFMA	Survey	Shoreline Length - exposed	Shoreline Length - protected	Confidence Level	Biomass (kg) LCB	Biomass (kg) UCB
12–37	Tribune Channel	0	11,844	99	4,221	8,442
				95	4,605	7,675
				90	4,797	7,291
				75	4,989	6,907
12–42	Drury Inlet	0	108,602	99	14,672	111,089
				95	20,960	104,801
				90	23,056	92,225
				75	27,248	73,361
12–43	Kingcome – Wakeman	0	32,642	99	2,651	11,927
				95	3,313	10,602
				90	3,313	9,939
				75	4,638	8,614
12–45*	Kingcome – Wakeman	0	50,668	99	4,114	21,600
				95	5,143	18,514
				90	6,171	16,457
				75	7,200	14,400
12–46*	Kingcome – Wakeman	4,238	3,086	99	595	3,122
				95	743	2,676
				90	892	2,379
				75	1,041	2,081
12–47*	Kingcome – Wakeman	0	17,590	99	357	5,356
				95	714	4,285
				90	714	3,928
				75	1,071	3,571
12–48*	Kingcome – Wakeman	1,545	5,763	99	148	2,225
				95	297	1,780
				90	297	1,632
				75	445	1,484
27–7	Quastino Sound	292	95,366	99	2,898	14,492
				95	2,898	14,492
				90	2,898	11,594
				75	2,898	11,594
27–8*	Quastino Sound	2,694	60,708	99	0	3,842
				95	0	1,921
				90	0	1,921
				75	0	1,921

Table 4, cont'd.

PFMA	Survey	Shoreline Length - exposed	Shoreline Length - protected	Confidence Level	Biomass (kg) LCB	Biomass (kg) UCB
27–9*	Quastino Sound	0	19,689	99	0	12,528
				95	0	10,738
				90	597	8,352
				75	1,193	6,562
27–10*	Quastino Sound	1,138	18,651	99	0	1,199
				95	0	1,199
				90	0	600
				75	0	600
27–11*	Quastino Sound	2,430	79,016	99	0	2,468
				95	0	2,468
				90	0	2,468
				75	0	0

Table 5. Linear density (sea cucumbers per meter shoreline; c/m-sh) for *Parastichopus californicus*, *Cucumaria miniata* and *C. pallida*, by transect, in the Petrel – South Principe survey.

				Linear Density (c/m-sh)		
Survey	PFMA	SubArea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
Petrel and South Principe	5	17	1	11.00	--	--
Petrel and South Principe	5	17	2	6.50	--	--
Petrel and South Principe	5	17	3	13.00	--	--
Petrel and South Principe	5	17	4	7.00	--	--
Petrel and South Principe	5	17	5	2.25	--	--
Petrel and South Principe	5	17	6	1.75	--	--
Petrel and South Principe	5	17	7	6.50	--	--
Petrel and South Principe	5	17	8	25.75	--	--
Petrel and South Principe	5	17	9	2.50	--	--
Petrel and South Principe	5	17	10	0.75	--	--
Petrel and South Principe	5	17	11	5.25	--	--
Petrel and South Principe	5	17	12	0.25	--	--
Petrel and South Principe	5	17	13	0.25	--	--
Petrel and South Principe	5	17	14	5.50	--	--
Petrel and South Principe	5	17	15	4.00	--	--
Petrel and South Principe	5	17	16	7.50	--	--
Petrel and South Principe	5	17	17	1.75	--	--
Petrel and South Principe	5	17	18	19.00	--	--
Petrel and South Principe	5	17	19	5.50	--	--
Petrel and South Principe	5	17	20	12.00	--	--
Petrel and South Principe	5	17	21	1.25	--	--
Petrel and South Principe	5	17	25	6.75	--	--
Petrel and South Principe	5	17	26	1.50	--	--
Petrel and South Principe	5	17	27	1.75	--	--
Petrel and South Principe	5	17	28	6.75	--	--
Petrel and South Principe	5	17	29	3.75	--	--
Petrel and South Principe	5	17	30	10.75	--	--
Petrel and South Principe	5	17	32	5.00	--	--
Petrel and South Principe	5	17	33	1.50	--	--
Petrel and South Principe	5	17	34	6.00	--	--
Petrel and South Principe	5	17	35	5.50	--	--
Petrel and South Principe	5	17	36	3.25	--	--
Petrel and South Principe	5	17	37	4.75	--	--
Petrel and South Principe	5	17	38	2.75	--	--
Petrel and South Principe	5	17	39	12.00	--	--
Petrel and South Principe	5	17	40	5.00	--	--
Petrel and South Principe	5	17	41	0.50	--	--
Petrel and South Principe	5	17	42	4.00	--	--
Petrel and South Principe	5	17	43	3.00	--	--
Petrel and South Principe	5	17	44	6.50	--	--
Petrel and South Principe	5	17	45	22.50	--	--
Petrel and South Principe	5	17	46	3.75	--	--
Petrel and South Principe	5	17	47	11.75	--	--
Petrel and South Principe	5	17	48	3.50	--	--
Petrel and South Principe	5	17	49	2.00	--	--
Petrel and South Principe	5	17	50	19.00	--	--

Table 5, Petrel – South Principe, cont'd.

				Linear Density (c/m-sh)		
Survey	PFMA	SubArea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
Petrel and South Principe	5	17	51	8.50	--	–
Petrel and South Principe	5	17	52	2.75	--	–
Petrel and South Principe	5	17	53	11.75	--	–
Petrel and South Principe	5	17	54	14.50	--	–
Petrel and South Principe	5	17	55	1.75	--	–
Petrel and South Principe	5	17	56	8.25	--	–
Petrel and South Principe	5	17	57	6.50	--	–
Petrel and South Principe	5	17	58	2.75	--	–
Petrel and South Principe	5	17	59	4.50	--	–
Petrel and South Principe	5	17	60	0.50	--	–
Petrel and South Principe	5	17	61	5.50	--	–
Petrel and South Principe	5	17	62	0.50	--	–
Petrel and South Principe	5	17	63	4.00	--	–
Petrel and South Principe	5	17	64	14.50	--	–
Petrel and South Principe	5	17	65	2.50	--	–
Petrel and South Principe	5	17	66	3.75	--	–
Petrel and South Principe	5	17	67	5.75	--	–
Petrel and South Principe	5	17	68	25.75	--	–
Petrel and South Principe	5	17	69	2.25	--	–
Petrel and South Principe	5	17	70	3.75	--	–
Petrel and South Principe	5	17	71	3.00	--	–
Petrel and South Principe	5	17	72	14.75	--	–
Petrel and South Principe	5	17	73	7.25	--	–
Petrel and South Principe	5	17	74	32.75	--	–
Petrel and South Principe	5	17	75	2.50	--	–
Petrel and South Principe	5	17	76	12.75	--	–
Petrel and South Principe	5	17	77	14.25	--	–
Petrel and South Principe	5	17	78	6.50	--	–
Petrel and South Principe	5	17	79	6.25	--	–
Petrel and South Principe	5	17	80	3.75	--	–
Petrel and South Principe	5	17	81	2.00	--	–
Petrel and South Principe	5	17	82	4.75	--	–
Petrel and South Principe	5	17	83	9.75	--	–
Petrel and South Principe	5	17	84	12.00	--	–
Petrel and South Principe	5	16	85	10.25	--	–
Petrel and South Principe	5	16	86	6.75	--	–
Petrel and South Principe	5	16	87	1.25	--	–
Petrel and South Principe	5	16	88	1.00	--	–
Petrel and South Principe	5	16	89	0.25	--	–
Petrel and South Principe	5	16	90	8.75	--	–
Petrel and South Principe	5	16	91	5.25	--	–
Petrel and South Principe	5	16	92	23.25	--	–
Petrel and South Principe	5	16	93	7.00	--	–
Petrel and South Principe	5	16	94	1.00	--	–
Petrel and South Principe	5	16	95	0.75	--	–
Petrel and South Principe	5	16	96	1.50	--	–

Table 5, Petrel – South Principe, cont'd.

Survey	PFMA	SubArea	Transect No.	Linear Density (c/m-sh)		
				P. californicus	*C. miniata*	*C. pallida*
Petrel and South Principe	5	16	97	32.00	--	–
Petrel and South Principe	5	16	98	0.75	--	–
Petrel and South Principe	5	16	99	6.75	--	–
Petrel and South Principe	5	16	100	9.50	--	–
Petrel and South Principe	5	16	101	5.25	--	–
Petrel and South Principe	5	16	102	7.00	--	–
Petrel and South Principe	5	16	103	13.75	--	–
Petrel and South Principe	5	16	104	4.00	--	–
Petrel and South Principe	5	16	105	26.50	--	–
Petrel and South Principe	5	16	106	0.50	--	–
Petrel and South Principe	5	16	107	8.75	--	–
Petrel and South Principe	5	16	108	5.75	--	–
Petrel and South Principe	5	16	109	8.50	--	–
Petrel and South Principe	5	16	110	18.75	--	–
Petrel and South Principe	5	16	111	4.25	--	–
Petrel and South Principe	5	16	112	4.00	--	–
Petrel and South Principe	5	16	113	7.50	--	–
Petrel and South Principe	5	16	114	23.50	--	–
Petrel and South Principe	5	16	115	23.00	--	–
Petrel and South Principe	5	16	116	4.00	--	–
Petrel and South Principe	5	16	117	5.25	--	–
Petrel and South Principe	5	16	118	13.25	--	–
Petrel and South Principe	5	16	119	4.25	--	–
Petrel and South Principe	5	16	120	3.00	--	–
Petrel and South Principe	5	16	121	7.25	--	–
Petrel and South Principe	5	16	122	4.25	--	–
Petrel and South Principe	5	16	123	6.75	--	–
Petrel and South Principe	5	16	124	8.25	--	–
Petrel and South Principe	5	16	125	1.75	--	–
Petrel and South Principe	5	16	126	1.75	--	–
Petrel and South Principe	5	16	127	7.00	--	–
Petrel and South Principe	5	16	128	5.00	--	–
Petrel and South Principe	5	16	129	2.75	--	–
Petrel and South Principe	5	16	130	2.75	--	–
Petrel and South Principe	5	16	131	15.75	--	–
Petrel and South Principe	5	16	132	10.00	--	–
Petrel and South Principe	5	16	133	1.25	--	–
Petrel and South Principe	5	16	134	15.75	--	–
Petrel and South Principe	5	16	135	16.00	--	–
Petrel and South Principe	5	16	136	8.25	--	–
Petrel and South Principe	5	16	137	9.25	--	–
Petrel and South Principe	5	16	138	5.50	--	–
Petrel and South Principe	5	16	139	5.75	--	–
Petrel and South Principe	5	16	140	5.50	--	–

Table 5, Petrel – South Principe, cont'd.

				Linear Density (c/m-sh)		
Survey	PFMA	SubArea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
Petrel and South Principe	5	16	141	0.00	--	–
Petrel and South Principe	5	16	142	7.75	--	–
Petrel and South Principe	5	16	143	0.75	--	–
Petrel and South Principe	5	16	144	4.50	--	–
Petrel and South Principe	5	16	145	6.75	--	–
Petrel and South Principe	5	16	146	6.00	--	–
Petrel and South Principe	5	16	147	6.50	--	–
Petrel and South Principe	5	16	148	7.75	--	–
Petrel and South Principe	5	16	149	9.50	--	–
Petrel and South Principe	5	16	150	12.75	--	–
Petrel and South Principe	5	16	151	5.75	--	–
Petrel and South Principe	5	16	152	9.50	--	–
Petrel and South Principe	5	16	153	8.00	--	–
Petrel and South Principe	5	16	154	21.00	--	–
Petrel and South Principe	5	16	155	16.75	--	–
Petrel and South Principe	5	16	156	12.50	--	–
Petrel and South Principe	5	16	157	27.00	--	–
Petrel and South Principe	5	16	158	1.00	--	–
Petrel and South Principe	5	16	159	7.50	--	–
Petrel and South Principe	5	16	160	19.25	--	–
Petrel and South Principe	5	16	161	25.25	--	–
Petrel and South Principe	5	16	162	4.00	--	–
Petrel and South Principe	5	16	168	46.00	--	–
Petrel and South Principe	5	16	169	4.00	--	–
Petrel and South Principe	5	16	170	17.75	--	–
Petrel and South Principe	5	16	171	8.00	--	–
Petrel and South Principe	5	16	172	7.25	--	–
Petrel and South Principe	5	16	173	10.50	--	–
Petrel and South Principe	5	16	174	10.50	--	–
Petrel and South Principe	5	16	175	5.50	--	–
Petrel and South Principe	5	16	176	15.00	--	–
Petrel and South Principe	5	16	177	5.50	--	–
Petrel and South Principe	5	16	178	7.75	--	–
Petrel and South Principe	5	16	179	7.50	--	–
Petrel and South Principe	5	16	180	3.25	--	–
Petrel and South Principe	5	16	181	14.25	--	–
Petrel and South Principe	5	16	182	0.25	--	–
Petrel and South Principe	5	16	183	0.75	--	–
Petrel and South Principe	5	16	184	9.75	--	–
Petrel and South Principe	5	16	185	20.00	--	–
Petrel and South Principe	5	16	186	3.50	--	–
Petrel and South Principe	5	16	187	7.50	--	–
Petrel and South Principe	5	16	188	7.25	--	–
Petrel and South Principe	5	16	189	12.25	--	–
Petrel and South Principe	5	14	190	1.00	--	–
Petrel and South Principe	5	14	191	1.50	--	–

Table 5, Petrel – South Principe, cont'd.

Survey	PFMA	SubArea	Transect No.	Linear Density (c/m-sh)		
				P. californicus	*C. miniata*	*C. pallida*
Petrel and South Principe	5	14	192	3.75	--	--
Petrel and South Principe	5	14	193	5.00	--	--
Petrel and South Principe	5	14	194	0.00	--	--
Petrel and South Principe	5	14	195	4.25	--	--
Petrel and South Principe	5	14	196	4.25	--	--
Petrel and South Principe	5	14	197	1.50	--	--
Petrel and South Principe	5	14	198	6.25	--	--
Petrel and South Principe	5	14	199	8.75	--	--
Petrel and South Principe	5	14	200	4.00	--	--
Petrel and South Principe	5	14	202	0.25	--	--
Petrel and South Principe	5	14	203	6.00	--	--
Petrel and South Principe	5	14	204	0.25	--	--
Petrel and South Principe	5	14	205	9.75	--	--
Petrel and South Principe	5	14	206	3.00	--	--
Petrel and South Principe	5	14	207	14.75	--	--
Petrel and South Principe	5	14	208	4.50	--	--
Petrel and South Principe	5	14	209	10.50	--	--
Petrel and South Principe	5	14	210	31.50	--	--
Petrel and South Principe	5	14	211	11.25	--	--
Petrel and South Principe	5	14	212	23.00	--	--
Petrel and South Principe	5	14	213	5.75	--	--
Petrel and South Principe	5	14	214	6.75	--	--
Petrel and South Principe	5	14	215	3.00	--	--
Petrel and South Principe	5	14	216	6.75	--	--
Petrel and South Principe	5	14	217	18.25	--	--
Petrel and South Principe	5	14	218	14.50	--	--
Petrel and South Principe	5	14	219	4.25	--	--
Petrel and South Principe	5	14	220	4.75	--	--
Petrel and South Principe	5	14	222	5.25	--	--
Petrel and South Principe	5	14	223	29.00	--	--
Petrel and South Principe	5	14	224	2.00	--	--
Petrel and South Principe	5	14	225	1.75	--	--
Petrel and South Principe	5	14	226	0.75	--	--
Petrel and South Principe	5	14	227	11.25	--	--
Petrel and South Principe	5	14	228	6.75	--	--
Petrel and South Principe	5	14	229	5.25	--	--
Petrel and South Principe	5	14	230	0.00	--	--
Petrel and South Principe	5	14	231	0.00	--	--
Petrel and South Principe	5	14	232	1.00	--	--
Petrel and South Principe	5	14	233	1.00	--	--
Petrel and South Principe	5	14	234	2.25	--	--
Petrel and South Principe	5	14	235	0.50	--	--
Petrel and South Principe	5	14	236	7.50	--	--

Table 6. Linear density (sea cucumbers per meter shoreline; c/m-sh) for *Parastichopus californicus*, *Cucumaria miniata* and *C. pallida*, by transect, in the West Aristazabal survey.

				Linear Density (c/m-sh)		
Survey	PFMA	SubArea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
West Aristazabal	6	13	1	0.50	5.5	0.0
West Aristazabal	6	13	2	14.50	28.5	4.0
West Aristazabal	6	13	3	2.75	1.0	0.0
West Aristazabal	6	13	4	0.50	1.5	0.0
West Aristazabal	6	13	5	0.75	3.0	0.0
West Aristazabal	6	13	6	14.00	24.5	0.0
West Aristazabal	6	13	7	15.00	5.5	8.0
West Aristazabal	6	13	8	10.25	1.5	0.0
West Aristazabal	6	13	9	1.25	55.5	0.0
West Aristazabal	6	13	10	1.50	3.0	0.0
West Aristazabal	6	13	11	0.50	1.5	0.0
West Aristazabal	6	13	12	2.50	0.0	0.0
West Aristazabal	6	13	13	2.00	7.5	0.0
West Aristazabal	6	13	14	4.75	71.0	2.5
West Aristazabal	6	13	15	0.50	0.0	0.0
West Aristazabal	6	13	16	0.25	0.5	0.0
West Aristazabal	6	13	17	11.00	18.0	0.0
West Aristazabal	6	13	18	0.75	5.5	0.0
West Aristazabal	6	13	19	1.00	2.0	0.0
West Aristazabal	6	13	20	3.25	26.0	0.0
West Aristazabal	6	13	21	2.00	2.5	0.0
West Aristazabal	6	13	22	2.50	0.0	0.0
West Aristazabal	6	13	23	1.50	7.5	1.0
West Aristazabal	6	13	24	2.25	10.5	0.0
West Aristazabal	6	13	25	3.50	21.0	0.0
West Aristazabal	6	13	26	0.00	0.0	0.0
West Aristazabal	6	13	27	6.25	88.5	16.5
West Aristazabal	6	13	28	7.50	93.5	5.5
West Aristazabal	6	13	29	0.75	62.5	2.0
West Aristazabal	6	13	30	0.00	7.5	0.0
West Aristazabal	6	13	31	6.00	14.0	0.0
West Aristazabal	6	13	32	0.25	0.0	0.0
West Aristazabal	6	13	33	0.00	0.0	0.0
West Aristazabal	6	13	34	0.00	0.0	0.0
West Aristazabal	6	13	36	4.25	82.5	1.0
West Aristazabal	6	13	37	1.00	70.5	0.0
West Aristazabal	6	13	38	2.00	0.0	0.0
West Aristazabal	6	13	39	0.25	1.0	0.0
West Aristazabal	6	13	40	25.00	3.0	0.0
West Aristazabal	6	13	41	1.00	2.5	0.0
West Aristazabal	6	13	42	1.50	13.5	0.0
West Aristazabal	6	13	43	0.25	27.0	0.0
West Aristazabal	6	13	44	0.00	0.0	0.0
West Aristazabal	6	13	45	0.50	4.5	0.0

Table 6, West Aristazabal survey cont'd.

				Linear Density (c/m-sh)		
Survey	PFMA	SubArea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
West Aristazabal	6	13	47	1.50	28.0	4.0
West Aristazabal	6	13	48	3.25	38.0	9.0
West Aristazabal	6	13	49	0.00	0.0	0.0
West Aristazabal	6	13	51	0.75	57.0	0.0
West Aristazabal	6	13	52	3.25	9.0	0.0
West Aristazabal	6	13	53	3.75	6.0	0.0
West Aristazabal	6	13	54	14.75	0.0	0.0
West Aristazabal	6	13	55	0.25	0.0	0.0
West Aristazabal	6	13	56	0.25	0.0	0.0
West Aristazabal	6	13	57	0.00	0.0	0.0
West Aristazabal	6	13	58	0.00	0.0	0.0
West Aristazabal	6	13	59	0.00	0.0	0.0
West Aristazabal	6	13	60	0.00	0.0	0.0
West Aristazabal	6	13	61	2.75	2.0	0.0
West Aristazabal	6	13	62	7.50	24.0	0.0
West Aristazabal	6	13	63	6.00	1.5	0.0
West Aristazabal	6	13	64	4.25	23.0	0.5
West Aristazabal	6	13	65	7.00	1.0	0.0
West Aristazabal	6	13	66	0.25	1.0	0.0
West Aristazabal	6	13	67	12.00	9.0	0.0
West Aristazabal	6	13	70	17.00	67.5	0.0
West Aristazabal	6	13	71	7.75	36.0	0.0
West Aristazabal	6	13	72	1.25	21.5	0.0
West Aristazabal	6	13	73	0.00	5.5	0.0
West Aristazabal	6	13	74	6.00	6.5	0.0
West Aristazabal	6	13	75	0.00	5.0	0.5
West Aristazabal	6	13	76	0.75	4.5	0.0
West Aristazabal	6	13	77	1.50	5.5	0.5
West Aristazabal	6	13	78	2.50	0.0	0.0
West Aristazabal	6	13	79	2.25	4.0	0.0
West Aristazabal	6	13	81	0.75	2.0	0.5
West Aristazabal	6	13	82	2.25	9.0	0.0
West Aristazabal	6	13	83	15.25	58.0	0.0
West Aristazabal	6	13	84	0.00	1.0	0.0
West Aristazabal	6	13	86	18.75	0.0	0.0
West Aristazabal	6	13	87	14.50	27.0	3.0
West Aristazabal	6	13	88	3.50	59.5	0.0
West Aristazabal	6	13	89	5.00	22.5	0.0
West Aristazabal	6	13	90	19.50	22.5	0.5
West Aristazabal	6	13	91	4.75	14.5	0.0
West Aristazabal	6	13	92	0.00	4.5	0.0
West Aristazabal	6	13	93	1.00	14.5	0.0
West Aristazabal	6	13	94	2.25	17.0	0.0
West Aristazabal	6	13	95	0.50	2.5	0.0
West Aristazabal	6	13	96	0.25	0.0	0.0
West Aristazabal	6	13	97	0.00	0.0	0.0

Table 6, West Aristazabal survey cont'd.

				Linear Density (c/m-sh)		
Survey	PFMA	SubArea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
West Aristazabal	6	13	98	8.50	28.0	1.0
West Aristazabal	6	13	100	2.25	20.0	0.0
West Aristazabal	6	13	101	0.25	23.5	1.0
West Aristazabal	6	13	102	0.00	0.0	0.0
West Aristazabal	6	13	103	0.00	0.0	0.0
West Aristazabal	6	13	104	8.50	95.5	0.0
West Aristazabal	6	13	105	7.25	52.5	5.5
West Aristazabal	6	13	106	20.25	2.5	0.0
West Aristazabal	6	13	107	0.75	21.0	0.0
West Aristazabal	6	13	108	6.25	22.0	1.5
West Aristazabal	6	13	109	8.50	34.0	0.5
West Aristazabal	6	13	110	0.00	37.0	0.0
West Aristazabal	6	13	111	7.25	31.0	0.5
West Aristazabal	6	13	112	1.75	22.0	1.0
West Aristazabal	6	13	113	9.75	69.0	2.5
West Aristazabal	6	13	114	0.25	6.5	0.0
West Aristazabal	6	13	118	1.25	27.5	0.0
West Aristazabal	6	13	119	1.00	63.0	1.0
West Aristazabal	6	13	120	1.50	108.0	0.0
West Aristazabal	6	13	121	1.75	23.0	0.0
West Aristazabal	6	13	122	9.75	6.5	0.0
West Aristazabal	6	13	123	4.75	19.0	0.0
West Aristazabal	6	13	124	0.00	0.0	0.0
West Aristazabal	6	13	125	0.00	0.0	0.0
West Aristazabal	6	13	126	0.25	6.5	0.0
West Aristazabal	6	13	127	0.50	52.0	0.0

Table 7. Linear density (sea cucumbers per meter shoreline; c/m-sh) for *Parastichopus californicus*, *Cucumaria miniata* and *C. pallida*, by transect, in the Seaforth – Spiller Channel survey.

				Linear Density (c/m-sh)		
Survey	PFMA	SubArea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
Seaforth and Spiller Channel	7	12	78	0.00	0.0	0.0
Seaforth and Spiller Channel	7	12	79	0.25	0.0	0.0
Seaforth and Spiller Channel	7	12	80	2.50	0.0	0.0
Seaforth and Spiller Channel	7	12	81	0.00	0.0	0.0
Seaforth and Spiller Channel	7	12	82	0.00	0.0	0.0
Seaforth and Spiller Channel	7	12	83	0.75	0.0	0.0
Seaforth and Spiller Channel	7	12	84	0.00	0.5	0.0
Seaforth and Spiller Channel	7	12	85	9.25	1.0	0.0
Seaforth and Spiller Channel	7	12	86	18.25	0.0	0.0
Seaforth and Spiller Channel	7	12	87	22.75	0.0	0.5
Seaforth and Spiller Channel	7	12	88	3.25	0.0	0.0
Seaforth and Spiller Channel	7	12	89	0.50	0.0	0.0
Seaforth and Spiller Channel	7	12	90	5.75	3.0	0.0
Seaforth and Spiller Channel	7	12	91	13.25	8.5	4.0
Seaforth and Spiller Channel	7	12	92	1.25	0.5	0.0
Seaforth and Spiller Channel	7	12	93	8.25	0.0	0.0
Seaforth and Spiller Channel	7	12	94	8.25	78.0	11.5
Seaforth and Spiller Channel	7	12	95	13.00	0.0	0.0
Seaforth and Spiller Channel	7	12	96	10.75	19.5	5.5
Seaforth and Spiller Channel	7	12	97	19.00	48.0	16.5
Seaforth and Spiller Channel	7	12	98	5.00	4.0	3.0
Seaforth and Spiller Channel	7	12	99	1.50	4.0	2.5
Seaforth and Spiller Channel	7	12	100	28.75	55.5	6.0
Seaforth and Spiller Channel	7	12	101	10.75	0.0	0.5
Seaforth and Spiller Channel	7	12	102	8.75	0.0	2.0
Seaforth and Spiller Channel	7	12	103	3.25	56.0	6.0
Seaforth and Spiller Channel	7	12	104	6.00	30.5	1.5
Seaforth and Spiller Channel	7	12	105	6.75	40.0	30.5
Seaforth and Spiller Channel	7	12	106	11.75	1.0	0.5
Seaforth and Spiller Channel	7	12	107	3.00	0.5	3.0
Seaforth and Spiller Channel	7	12	108	7.50	1.0	2.0
Seaforth and Spiller Channel	7	12	109	3.25	0.0	0.0
Seaforth and Spiller Channel	7	12	110	0.50	0.0	0.0
Seaforth and Spiller Channel	7	12	111	0.25	0.0	0.0
Seaforth and Spiller Channel	7	12	112	1.00	0.0	1.0
Seaforth and Spiller Channel	7	12	113	10.50	3.0	0.0
Seaforth and Spiller Channel	7	12	114	3.50	19.0	0.0
Seaforth and Spiller Channel	7	12	115	6.75	0.0	0.0
Seaforth and Spiller Channel	7	12	116	10.50	0.0	0.0
Seaforth and Spiller Channel	7	12	117	40.00	11.5	0.0
Seaforth and Spiller Channel	7	12	118	18.00	12.5	0.0
Seaforth and Spiller Channel	7	12	119	7.25	0.0	0.0
Seaforth and Spiller Channel	7	12	120	9.25	0.0	0.0
Seaforth and Spiller Channel	7	13	121	9.25	1.0	1.0
Seaforth and Spiller Channel	7	13	122	4.50	1.0	1.5
Seaforth and Spiller Channel	7	13	123	1.50	1.0	2.5
Seaforth and Spiller Channel	7	13	124	2.75	0.0	0.0
Seaforth and Spiller Channel	7	13	125	5.75	0.5	0.0

Table 7, Seaforth – Spiller Channel survey cont'd.

				Linear Density (c/m-sh)		
Survey	PFMA	SubArea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
Seaforth and Spiller Channel	7	13	126	3.50	0.5	1.5
Seaforth and Spiller Channel	7	13	127	18.00	34.0	27.5
Seaforth and Spiller Channel	7	13	128	2.25	3.0	6.5
Seaforth and Spiller Channel	7	13	129	0.25	0.5	3.0
Seaforth and Spiller Channel	7	13	130	6.50	0.0	13.0
Seaforth and Spiller Channel	7	13	131	1.25	13.5	11.5
Seaforth and Spiller Channel	7	13	132	6.50	5.0	0.0
Seaforth and Spiller Channel	7	13	133	19.25	0.0	0.0
Seaforth and Spiller Channel	7	13	134	6.25	0.5	0.0
Seaforth and Spiller Channel	7	13	135	24.00	0.0	0.5
Seaforth and Spiller Channel	7	13	136	0.75	0.0	0.5
Seaforth and Spiller Channel	7	13	137	0.75	1.0	1.0
Seaforth and Spiller Channel	7	13	138	0.75	2.5	8.0
Seaforth and Spiller Channel	7	13	140	5.25	1.5	1.0
Seaforth and Spiller Channel	7	13	141	1.50	6.5	38.5
Seaforth and Spiller Channel	7	13	142	3.50	23.0	96.0
Seaforth and Spiller Channel	7	13	143	10.25	0.0	1.0
Seaforth and Spiller Channel	7	13	144	1.25	0.0	43.0
Seaforth and Spiller Channel	7	13	145	5.50	23.5	19.0
Seaforth and Spiller Channel	7	13	146	0.00	0.0	1.0
Seaforth and Spiller Channel	7	13	147	0.00	0.0	2.5
Seaforth and Spiller Channel	7	13	148	0.00	1.5	3.0
Seaforth and Spiller Channel	7	13	149	0.00	0.0	4.0
Seaforth and Spiller Channel	7	13	150	0.25	0.0	2.0
Seaforth and Spiller Channel	7	13	151	0.25	6.5	22.5
Seaforth and Spiller Channel	7	13	152	0.25	1.0	9.0
Seaforth and Spiller Channel	7	13	153	4.50	1.0	6.0
Seaforth and Spiller Channel	7	13	154	0.75	0.0	0.0
Seaforth and Spiller Channel	7	13	155	2.50	1.5	2.0
Seaforth and Spiller Channel	7	13	156	1.00	7.5	24.5

Table 8. Linear density (sea cucumbers per meter shoreline; c/m-sh) for *Parastichopus californicus*, *Cucumaria miniata* and *C. pallida*, by transect, in the Joassa Channel survey.

				Linear Density (c/m-sh)		
Survey	PFMA	SubArea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
Joassa Channel	7	23	1	6.25	0.0	3.5
Joassa Channel	7	23	2	1.75	2.5	1.0
Joassa Channel	7	23	3	0.00	0.0	0.0
Joassa Channel	7	23	4	0.25	0.0	0.0
Joassa Channel	7	23	5	1.50	0.0	0.0
Joassa Channel	7	23	6	0.00	0.0	0.0
Joassa Channel	7	23	7	1.25	0.5	0.5
Joassa Channel	7	23	8	9.50	0.0	2.5
Joassa Channel	7	23	9	0.25	0.5	0.0
Joassa Channel	7	23	10	0.75	0.5	0.0
Joassa Channel	7	23	11	0.75	0.0	3.0
Joassa Channel	7	23	12	3.00	1.0	0.5
Joassa Channel	7	23	13	3.75	0.0	3.5
Joassa Channel	7	23	14	3.25	2.0	0.0
Joassa Channel	7	23	15	0.50	0.0	0.0
Joassa Channel	7	23	16	1.75	0.0	0.0
Joassa Channel	7	23	17	3.50	1.5	5.5
Joassa Channel	7	23	18	9.50	31.0	5.0
Joassa Channel	7	23	19	3.50	1.5	2.5
Joassa Channel	7	23	20	1.75	0.0	0.5
Joassa Channel	7	23	21	0.00	0.0	2.0
Joassa Channel	7	23	22	0.00	0.0	0.0
Joassa Channel	7	23	23	0.50	0.0	0.0
Joassa Channel	7	23	24	0.00	1.0	0.0
Joassa Channel	7	23	25	1.00	5.5	1.5
Joassa Channel	7	23	26	2.00	0.5	1.0
Joassa Channel	7	23	27	0.50	0.0	1.0
Joassa Channel	7	23	28	2.00	2.0	1.5
Joassa Channel	7	23	29	5.25	0.0	12.5
Joassa Channel	7	23	30	0.50	0.0	0.5
Joassa Channel	7	23	31	0.50	0.0	0.5
Joassa Channel	7	23	32	0.00	0.0	0.0
Joassa Channel	7	23	33	4.00	2.0	1.5
Joassa Channel	7	23	34	0.25	0.0	0.0
Joassa Channel	7	23	35	2.00	3.5	0.0
Joassa Channel	7	23	36	0.25	0.0	1.0
Joassa Channel	7	23	37	0.00	0.0	0.0
Joassa Channel	7	23	38	0.00	0.0	2.0
Joassa Channel	7	23	39	1.50	2.0	2.5
Joassa Channel	7	23	40	0.25	0.0	0.0
Joassa Channel	7	23	41	0.00	2.5	6.0
Joassa Channel	7	23	42	3.00	0.5	2.0
Joassa Channel	7	23	43	1.00	0.0	1.0
Joassa Channel	7	23	44	3.75	0.0	0.0

Table 8, Joassa Channel survey cont'd.

				Linear Density (c/m-sh)		
Survey	PFMA	SubArea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
Joassa Channel	7	23	45	6.25	0.0	1.0
Joassa Channel	7	23	46	3.00	0.0	0.0
Joassa Channel	7	23	47	1.75	0.0	0.0
Joassa Channel	7	23	48	0.00	0.0	0.0
Joassa Channel	7	23	52	1.50	0.0	0.0
Joassa Channel	7	23	53	6.00	0.0	0.0
Joassa Channel	7	23	54	9.75	0.5	0.0
Joassa Channel	7	23	55	4.50	27.0	3.0
Joassa Channel	7	23	56	3.75	1.0	1.5
Joassa Channel	7	23	57	8.25	0.0	1.0
Joassa Channel	7	23	58	1.25	0.0	0.0
Joassa Channel	7	23	59	2.25	0.0	0.0
Joassa Channel	7	23	60	0.75	0.0	0.0
Joassa Channel	7	23	61	3.25	0.0	0.0
Joassa Channel	7	23	62	1.25	0.0	0.0
Joassa Channel	7	23	63	4.00	0.0	0.0
Joassa Channel	7	23	64	3.50	0.0	0.0
Joassa Channel	7	23	65	1.00	0.0	0.0
Joassa Channel	7	23	66	11.50	0.0	0.0
Joassa Channel	7	23	67	0.00	0.0	0.0
Joassa Channel	7	23	68	1.00	0.0	0.0
Joassa Channel	7	23	69	1.50	0.0	2.5
Joassa Channel	7	23	70	2.00	0.0	0.0
Joassa Channel	7	22	71	2.25	2.0	0.5
Joassa Channel	7	22	72	2.50	0.0	5.5
Joassa Channel	7	22	73	8.25	0.0	0.0
Joassa Channel	7	22	74	5.25	0.5	0.0
Joassa Channel	7	22	75	4.50	0.5	9.5
Joassa Channel	7	22	76	8.25	1.5	2.0
Joassa Channel	7	22	77	3.25	0.0	0.0

Table 9. Linear density (sea cucumbers per meter shoreline; c/m-sh) for *Parastichopus californicus*, *Cucumaria miniata* and *C. pallida*, by transect, in the Tribune Channel survey.

				Linear Density (c/m-sh)		
Survey	PFMA	SubArea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
Tribune Channel	12	35	1	4.75	0.0	0.0
Tribune Channel	12	35	2	0.00	0.0	0.0
Tribune Channel	12	35	3	4.25	4.5	0.0
Tribune Channel	12	35	4	1.50	3.0	0.0
Tribune Channel	12	35	5	7.50	0.0	0.0
Tribune Channel	12	35	6	6.75	0.0	0.0
Tribune Channel	12	35	7	3.00	0.0	0.0
Tribune Channel	12	35	8	3.50	0.0	0.0
Tribune Channel	12	35	9	0.00	0.0	0.0
Tribune Channel	12	35	10	0.00	0.0	0.0
Tribune Channel	12	35	11	1.25	0.0	0.0
Tribune Channel	12	35	12	3.25	0.5	0.0
Tribune Channel	12	35	13	10.00	3.0	0.0
Tribune Channel	12	35	14	5.25	0.0	0.0
Tribune Channel	12	35	15	6.25	0.0	0.0
Tribune Channel	12	35	16	0.25	0.0	0.0
Tribune Channel	12	35	17	6.50	0.0	0.0
Tribune Channel	12	37	18	4.25	0.0	0.0
Tribune Channel	12	37	19	7.50	0.0	0.0
Tribune Channel	12	37	20	10.00	4.5	0.0
Tribune Channel	12	37	21	10.25	0.0	0.0
Tribune Channel	12	37	22	0.00	0.0	0.0
Tribune Channel	12	37	23	1.50	4.5	0.0
Tribune Channel	12	37	24	0.25	0.0	0.0
Tribune Channel	12	35	25	0.50	0.0	0.0
Tribune Channel	12	35	26	0.25	0.0	0.0
Tribune Channel	12	35	27	6.25	0.0	0.0
Tribune Channel	12	35	28	1.75	0.0	0.0
Tribune Channel	12	35	29	0.25	0.0	0.0
Tribune Channel	12	35	30	1.25	0.0	0.0
Tribune Channel	12	35	31	1.00	--	--
Tribune Channel	12	35	32	1.25	0.0	0.0
Tribune Channel	12	35	33	0.50	0.0	0.0
Tribune Channel	12	35	34	3.25	--	--
Tribune Channel	12	35	35	1.75	--	--
Tribune Channel	12	35	36	4.50	--	--
Tribune Channel	12	35	37	0.00	--	--
Tribune Channel	12	35	38	0.00	--	--
Tribune Channel	12	35	39	0.00	--	--
Tribune Channel	12	35	40	0.00	--	--
Tribune Channel	12	35	41	1.75	--	--
Tribune Channel	12	35	42	1.75	--	--
Tribune Channel	12	35	43	1.25	--	--
Tribune Channel	12	35	44	4.25	--	--

Table 9, Tribune Channel cont'd.

Survey	PFMA	SubArea	Transect No.	Linear Density (c/m-sh) *P. californicus*	*C. miniata*	*C. pallida*
Tribune Channel	12	35	45	5.50	--	–
Tribune Channel	12	35	46	0.75	--	–
Tribune Channel	12	35	47	2.50	--	–
Tribune Channel	12	35	48	0.00	--	–
Tribune Channel	12	35	49	0.25	--	–
Tribune Channel	12	35	50	0.00	--	–
Tribune Channel	12	35	51	3.00	--	–
Tribune Channel	12	35	52	2.25	--	–
Tribune Channel	12	35	53	0.50	--	–
Tribune Channel	12	35	54	3.25	--	–
Tribune Channel	12	35	55	3.50	--	–
Tribune Channel	12	35	56	0.00	--	–
Tribune Channel	12	35	57	13.00	--	–
Tribune Channel	12	35	58	11.50	--	–
Tribune Channel	12	35	59	1.00	--	–
Tribune Channel	12	35	60	3.25	--	–
Tribune Channel	12	35	61	2.00	--	–
Tribune Channel	12	35	62	3.00	--	–
Tribune Channel	12	35	63	17.25	--	–
Tribune Channel	12	35	64	1.25	--	–
Tribune Channel	12	35	65	10.25	--	–
Tribune Channel	12	35	66	0.00	--	–
Tribune Channel	12	35	67	1.75	--	–
Tribune Channel	12	35	68	4.00	--	–
Tribune Channel	12	35	69	2.75	--	–
Tribune Channel	12	35	70	2.00	--	–
Tribune Channel	12	35	71	1.00	--	–
Tribune Channel	12	35	72	0.00	--	–
Tribune Channel	12	35	73	0.25	--	–
Tribune Channel	12	35	74	1.50	--	–
Tribune Channel	12	36	75	0.00	0.0	0.0
Tribune Channel	12	36	76	2.25	4.5	0.0
Tribune Channel	12	36	77	0.00	0.0	0.0
Tribune Channel	12	36	78	0.00	0.0	0.0
Tribune Channel	12	36	79	0.00	0.0	0.0
Tribune Channel	12	36	80	0.50	0.0	0.0
Tribune Channel	12	36	81	5.25	0.0	0.0
Tribune Channel	12	36	82	0.75	4.5	0.0
Tribune Channel	12	36	83	0.25	0.0	0.0
Tribune Channel	12	36	84	1.00	1.5	0.5
Tribune Channel	12	36	85	0.00	0.0	0.0

Table 10. Linear density (sea cucumbers per meter shoreline; c/m-sh) for *Parastichopus californicus*, *Cucumaria miniata* and *C. pallida*, by transect, in the Drury Inlet survey.

				Linear Density (c/m-sh)		
Survey	PFMA	SubArea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
Drury Inlet	12	42	1	9.25	0.0	0.0
Drury Inlet	12	42	2	12.25	1.0	0.0
Drury Inlet	12	42	3	39.00	0.0	0.0
Drury Inlet	12	42	4	26.75	0.0	0.0
Drury Inlet	12	42	5	0.00	0.0	0.0
Drury Inlet	12	42	6	0.25	0.0	0.0
Drury Inlet	12	42	7	0.00	0.0	0.0
Drury Inlet	12	42	8	0.00	0.0	0.0
Drury Inlet	12	42	9	0.00	0.0	0.0
Drury Inlet	12	42	10	0.00	0.0	0.0
Drury Inlet	12	42	11	0.00	0.0	0.0
Drury Inlet	12	42	12	0.00	0.0	0.0
Drury Inlet	12	42	13	0.00	0.0	0.0
Drury Inlet	12	42	14	0.00	0.0	0.0
Drury Inlet	12	42	15	0.00	0.0	0.0
Drury Inlet	12	42	16	0.25	0.0	0.0
Drury Inlet	12	42	17	0.25	0.0	0.0
Drury Inlet	12	42	18	0.00	0.0	0.0
Drury Inlet	12	42	19	0.00	0.0	0.0
Drury Inlet	12	42	20	0.00	0.0	0.0
Drury Inlet	12	42	21	2.50	0.0	0.0
Drury Inlet	12	42	22	0.00	0.0	0.0
Drury Inlet	12	42	23	0.00	0.0	0.0
Drury Inlet	12	42	24	0.00	0.0	0.0
Drury Inlet	12	42	26	0.00	0.0	0.0
Drury Inlet	12	42	27	0.00	0.0	0.0
Drury Inlet	12	42	28	0.00	0.0	0.0
Drury Inlet	12	42	29	0.00	0.0	0.0
Drury Inlet	12	42	32	0.00	0.0	0.0
Drury Inlet	12	42	33	0.00	0.0	0.0
Drury Inlet	12	42	34	0.00	0.0	0.0
Drury Inlet	12	42	43	0.00	0.0	0.0
Drury Inlet	12	42	45	0.00	0.0	0.0
Drury Inlet	12	42	46	0.00	0.0	0.0
Drury Inlet	12	42	47	0.00	0.0	0.0
Drury Inlet	12	42	48	0.00	0.0	0.0
Drury Inlet	12	42	49	0.00	0.0	0.0
Drury Inlet	12	42	50	0.00	0.0	0.0
Drury Inlet	12	42	51	0.00	0.0	0.0
Drury Inlet	12	42	52	0.00	0.0	0.0
Drury Inlet	12	42	53	0.00	0.0	0.0
Drury Inlet	12	42	54	0.00	0.0	0.0
Drury Inlet	12	42	55	0.00	0.0	0.0
Drury Inlet	12	42	56	0.00	0.0	0.0

Table 10, Drury Inlet cont'd.

Survey	PFMA	SubArea	Transect No.	Linear Density (c/m-sh) *P. californicus*	*C. miniata*	*C. pallida*
Drury Inlet	12	42	57	0.00	0.0	0.0
Drury Inlet	12	42	58	0.00	0.0	0.0
Drury Inlet	12	42	59	0.00	0.0	0.0
Drury Inlet	12	42	60	0.00	0.0	0.0
Drury Inlet	12	42	61	0.00	0.0	0.0
Drury Inlet	12	42	62	0.00	0.0	0.0
Drury Inlet	12	42	63	1.50	1.0	0.0
Drury Inlet	12	42	64	2.75	0.0	0.0
Drury Inlet	12	42	65	8.00	1.5	0.0
Drury Inlet	12	42	66	1.75	0.0	0.0
Drury Inlet	12	42	67	3.25	0.0	0.0
Drury Inlet	12	42	68	12.75	0.0	0.0

Table 11. Linear density (sea cucumbers per meter shoreline; c/m-sh) for *Parastichopus californicus*, *Cucumaria miniata* and *C. pallida*, by transect, in the Kingcome – Wakeman survey.

				Linear Density (c/m-sh)		
Survey	PFMA	SubArea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
Kingcome-Wakeman	12	43	1	0.00	--	–
Kingcome-Wakeman	12	43	2	0.00	--	–
Kingcome-Wakeman	12	43	3	3.25	--	–
Kingcome-Wakeman	12	43	4	2.50	--	–
Kingcome-Wakeman	12	43	5	0.00	--	–
Kingcome-Wakeman	12	43	6	1.75	--	–
Kingcome-Wakeman	12	43	7	1.00	--	–
Kingcome-Wakeman	12	43	8	0.50	--	–
Kingcome-Wakeman	12	43	9	0.00	--	–
Kingcome-Wakeman	12	43	10	1.50	--	–
Kingcome-Wakeman	12	43	11	2.75	0.0	0.0
Kingcome-Wakeman	12	43	12	0.00	0.0	0.0
Kingcome-Wakeman	12	43	13	3.50	0.0	0.0
Kingcome-Wakeman	12	43	14	0.00	0.0	0.0
Kingcome-Wakeman	12	43	15	2.00	0.0	0.0
Kingcome-Wakeman	12	43	16	0.00	0.0	0.0
Kingcome-Wakeman	12	43	17	0.00	0.0	0.0
Kingcome-Wakeman	12	43	18	0.25	0.0	0.0
Kingcome-Wakeman	12	43	19	0.25	0.0	0.0
Kingcome-Wakeman	12	43	20	0.25	2.5	0.0
Kingcome-Wakeman	12	47	21	1.75	--	–
Kingcome-Wakeman	12	47	22	2.75	--	–
Kingcome-Wakeman	12	47	23	0.25	--	–
Kingcome-Wakeman	12	48	24	0.00	--	–
Kingcome-Wakeman	12	48	25	0.00	0.0	0.0
Kingcome-Wakeman	12	48	26	0.00	0.0	0.0
Kingcome-Wakeman	12	48	27	0.00	0.0	0.0
Kingcome-Wakeman	12	48	28	0.00	0.0	0.0
Kingcome-Wakeman	12	48	29	0.25	0.0	0.0
Kingcome-Wakeman	12	47	30	0.75	0.0	0.0
Kingcome-Wakeman	12	47	31	0.00	0.0	0.0
Kingcome-Wakeman	12	47	32	2.75	0.0	0.0
Kingcome-Wakeman	12	47	33	0.00	0.0	0.0
Kingcome-Wakeman	12	45	34	0.00	0.0	0.0
Kingcome-Wakeman	12	45	35	0.75	0.0	0.0
Kingcome-Wakeman	12	45	36	0.00	0.0	0.0
Kingcome-Wakeman	12	45	37	6.50	0.0	0.0
Kingcome-Wakeman	12	45	38	0.75	0.0	0.0
Kingcome-Wakeman	12	45	39	3.00	0.0	2.0
Kingcome-Wakeman	12	45	41	4.25	0.0	0.0
Kingcome-Wakeman	12	45	42	2.25	0.0	0.0
Kingcome-Wakeman	12	45	43	0.25	0.0	0.0
Kingcome-Wakeman	12	45	44	0.00	0.0	0.0
Kingcome-Wakeman	12	45	45	6.00	0.0	0.0

Table 11, Kingcome – Wakeman cont'd.

				Linear Density (c/m-sh)		
Survey	PFMA	SubArea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
Kingcome-Wakeman	12	45	46	0.25	0.0	0.0
Kingcome-Wakeman	12	45	47	0.50	0.0	0.0
Kingcome-Wakeman	12	45	48	1.50	0.0	0.0
Kingcome-Wakeman	12	45	49	1.50	0.0	0.0
Kingcome-Wakeman	12	45	50	0.00	0.0	0.0
Kingcome-Wakeman	12	45	51	0.00	0.0	0.0
Kingcome-Wakeman	12	45	52	0.00	0.0	0.0
Kingcome-Wakeman	12	46	53	0.00	0.0	0.0
Kingcome-Wakeman	12	46	54	0.00	0.0	0.0
Kingcome-Wakeman	12	46	55	0.00	0.0	0.0
Kingcome-Wakeman	12	46	56	0.00	0.0	0.0
Kingcome-Wakeman	12	46	57	0.00	0.0	0.0
Kingcome-Wakeman	12	45	58	0.00	0.0	0.0
Kingcome-Wakeman	12	45	59	0.00	0.0	0.0
Kingcome-Wakeman	12	45	60	0.00	0.0	0.0
Kingcome-Wakeman	12	45	61	0.75	0.0	0.0
Kingcome-Wakeman	12	45	62	0.25	0.0	0.0
Kingcome-Wakeman	12	45	63	0.00	0.0	0.0
Kingcome-Wakeman	12	45	64	0.00	0.0	0.0
Kingcome-Wakeman	12	45	65	0.75	0.0	0.0
Kingcome-Wakeman	12	45	66	1.00	0.0	0.0
Kingcome-Wakeman	12	45	67	2.00	0.0	0.0

Table 12. Linear density (sea cucumbers per meter shoreline; c/m-sh) for *Parastichopus californicus*, *Cucumaria miniata* and *C. pallida*, by transect, in the Quatsino Sound survey.

				Linear Density (c/m-sh)		
Survey	PFMA	SubArea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
Quatsino Sound	27	7	2	0.00	--	--
Quatsino Sound	27	7	3	0.00	31.5	5.5
Quatsino Sound	27	7	4	0.00	0.0	0.0
Quatsino Sound	27	7	5	0.00	8.5	35.5
Quatsino Sound	27	7	6	0.00	0.0	0.0
Quatsino Sound	27	7	7	0.00	0.0	0.0
Quatsino Sound	27	7	8	0.00	0.0	0.0
Quatsino Sound	27	7	9	0.00	0.0	2.0
Quatsino Sound	27	7	10	0.00	0.0	0.0
Quatsino Sound	27	7	11	0.00	0.5	2.0
Quatsino Sound	27	7	12	0.00	1.5	5.0
Quatsino Sound	27	7	13	0.00	0.5	6.0
Quatsino Sound	27	7	14	0.00	1.5	10.5
Quatsino Sound	27	7	15	0.00	0.0	0.0
Quatsino Sound	27	7	16	0.00	0.0	0.0
Quatsino Sound	27	7	17	0.00	0.0	0.0
Quatsino Sound	27	7	18	0.00	0.0	0.0
Quatsino Sound	27	7	19	0.25	0.0	1.0
Quatsino Sound	27	7	20	0.00	0.0	0.0
Quatsino Sound	27	7	21	0.50	0.0	0.5
Quatsino Sound	27	7	22	0.50	0.5	9.5
Quatsino Sound	27	7	23	0.00	0.0	0.0
Quatsino Sound	27	7	24	4.00	2.5	48.5
Quatsino Sound	27	7	25	0.50	0.5	1.0
Quatsino Sound	27	7	26	0.00	0.0	0.5
Quatsino Sound	27	7	27	0.00	0.0	0.0
Quatsino Sound	27	7	28	0.25	0.0	4.0
Quatsino Sound	27	7	29	0.00	0.0	0.0
Quatsino Sound	27	7	30	2.00	0.5	37.5
Quatsino Sound	27	7	31	0.00	0.5	5.0
Quatsino Sound	27	7	32	0.00	0.0	0.0
Quatsino Sound	27	7	33	0.50	1.5	2.0
Quatsino Sound	27	7	34	0.25	0.0	0.0
Quatsino Sound	27	7	35	0.25	0.0	3.5
Quatsino Sound	27	7	36	0.00	0.0	0.0
Quatsino Sound	27	7	37	0.00	1.0	6.5
Quatsino Sound	27	7	38	0.00	0.0	0.0
Quatsino Sound	27	7	39	0.50	0.0	2.0
Quatsino Sound	27	7	40	1.00	0.5	35.5
Quatsino Sound	27	7	41	0.00	1.0	52.0
Quatsino Sound	27	7	42	0.50	1.5	0.5
Quatsino Sound	27	7	43	0.00	0.5	0.5
Quatsino Sound	27	7	44	0.25	0.5	3.0
Quatsino Sound	27	7	45	0.00	0.0	0.0
Quatsino Sound	27	7	46	0.00	8.5	18.0
Quatsino Sound	27	7	47	0.00	--	--
Quatsino Sound	27	7	48	0.25	--	--
Quatsino Sound	27	7	49	0.00	--	--

Table 12, Quatsino Sound cont'd.

				Linear Density (c/m-sh)		
Survey	PFMA	SubArea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
Quatsino Sound	27	7	51	0.00	--	--
Quatsino Sound	27	7	52	0.00	--	--
Quatsino Sound	27	7	53	0.00	--	--
Quatsino Sound	27	7	54	0.00	--	--
Quatsino Sound	27	7	55	0.00	--	--
Quatsino Sound	27	8	56	0.25	3.0	10.0
Quatsino Sound	27	8	57	0.00	0.5	6.5
Quatsino Sound	27	8	58	0.00	0.0	0.0
Quatsino Sound	27	8	59	0.00	0.0	0.0
Quatsino Sound	27	8	60	0.00	--	--
Quatsino Sound	27	8	61	1.00	--	--
Quatsino Sound	27	8	62	0.00	--	--
Quatsino Sound	27	8	63	0.00	--	--
Quatsino Sound	27	8	64	0.00	--	--
Quatsino Sound	27	8	65	0.00	--	--
Quatsino Sound	27	8	66	0.00	--	--
Quatsino Sound	27	8	67	0.00	--	--
Quatsino Sound	27	8	68	0.00	--	--
Quatsino Sound	27	8	69	0.00	0.0	0.0
Quatsino Sound	27	8	70	0.00	0.0	0.0
Quatsino Sound	27	8	71	0.00	0.0	0.0
Quatsino Sound	27	8	72	0.25	0.0	0.0
Quatsino Sound	27	8	73	0.00	0.0	0.0
Quatsino Sound	27	8	74	0.00	0.0	0.0
Quatsino Sound	27	8	75	0.00	0.0	0.0
Quatsino Sound	27	8	76	0.00	0.0	0.0
Quatsino Sound	27	8	77	0.00	0.0	0.0
Quatsino Sound	27	8	78	0.00	0.0	0.0
Quatsino Sound	27	8	79	0.00	0.0	0.0
Quatsino Sound	27	8	80	0.00	0.0	0.0
Quatsino Sound	27	8	81	0.00	0.0	0.0
Quatsino Sound	27	8	83	0.00	0.0	0.0
Quatsino Sound	27	8	84	0.00	0.0	0.0
Quatsino Sound	27	8	85	0.00	0.0	0.0
Quatsino Sound	27	8	87	0.00	0.0	1.5
Quatsino Sound	27	8	88	0.00	0.0	0.5
Quatsino Sound	27	9	89	0.00	--	--
Quatsino Sound	27	9	90	4.50	1.0	4.5
Quatsino Sound	27	9	91	0.00	0.0	0.0
Quatsino Sound	27	9	92	0.00	0.0	0.0
Quatsino Sound	27	9	93	0.25	1.5	1.5
Quatsino Sound	27	9	94	0.00	0.5	1.0
Quatsino Sound	27	9	95	0.00	33.5	1.0
Quatsino Sound	27	9	96	1.50	0.5	0.0
Quatsino Sound	27	9	97	0.00	0.5	0.0
Quatsino Sound	27	9	98	0.00	0.0	2.0
Quatsino Sound	27	9	99	0.00	0.0	0.5
Quatsino Sound	27	9	101	0.25	0.0	0.5

Table 12, Quatsino Sound cont'd.

				Linear Density (c/m-sh)		
Survey	PFMA	SubArea	Transect No.	*P. californicus*	*C. miniata*	*C. pallida*
Quatsino Sound	27	10	102	0.25	0.0	0.0
Quatsino Sound	27	10	103	0.00	0.0	0.0
Quatsino Sound	27	10	104	0.50	0.0	0.0
Quatsino Sound	27	10	105	0.00	0.0	0.0
Quatsino Sound	27	10	106	0.00	0.0	0.0
Quatsino Sound	27	10	107	0.00	0.0	0.0
Quatsino Sound	27	10	108	0.00	0.0	0.0
Quatsino Sound	27	10	109	0.00	0.0	0.0
Quatsino Sound	27	10	110	0.00	0.0	0.0
Quatsino Sound	27	10	111	0.00	0.0	0.0
Quatsino Sound	27	10	112	0.00	0.0	0.0
Quatsino Sound	27	10	115	0.00	0.0	0.0
Quatsino Sound	27	11	116	0.25	0.0	0.0
Quatsino Sound	27	11	117	0.50	0.5	0.0
Quatsino Sound	27	11	118	0.00	0.0	0.0
Quatsino Sound	27	11	119	0.00	0.0	0.0
Quatsino Sound	27	11	120	0.00	0.0	0.0
Quatsino Sound	27	11	121	0.00	--	--
Quatsino Sound	27	11	122	0.00	0.0	0.0
Quatsino Sound	27	11	123	0.00	0.0	0.0
Quatsino Sound	27	11	124	0.00	0.0	0.0
Quatsino Sound	27	11	125	0.25	0.0	0.0
Quatsino Sound	27	11	126	0.00	0.0	0.0
Quatsino Sound	27	11	127	0.50	0.0	0.0
Quatsino Sound	27	11	128	0.00	0.0	0.0
Quatsino Sound	27	11	129	0.00	0.0	0.0
Quatsino Sound	27	11	130	0.00	--	--
Quatsino Sound	27	11	131	0.00	--	--
Quatsino Sound	27	11	132	0.00	--	--
Quatsino Sound	27	11	133	0.00	--	--
Quatsino Sound	27	11	134	0.00	--	--
Quatsino Sound	27	11	135	0.00	--	--
Quatsino Sound	27	11	136	0.00	0.0	0.0
Quatsino Sound	27	11	137	0.00	0.0	0.0
Quatsino Sound	27	11	138	0.00	0.0	0.0
Quatsino Sound	27	11	139	0.00	0.0	0.0
Quatsino Sound	27	11	141	0.00	0.0	0.0
Quatsino Sound	27	11	142	0.00	0.0	0.0
Quatsino Sound	27	11	143	0.00	0.0	0.0
Quatsino Sound	27	11	144	0.00	0.0	0.0
Quatsino Sound	27	11	145	0.00	0.0	0.0
Quatsino Sound	27	11	146	0.00	0.0	0.0
Quatsino Sound	27	11	147	0.00	0.0	0.0
Quatsino Sound	27	11	148	0.00	0.0	0.0
Quatsino Sound	27	11	149	0.00	0.0	0.0
Quatsino Sound	27	11	150	0.00	0.0	0.0
Quatsino Sound	27	11	151	0.00	0.0	0.0
Quatsino Sound	27	11	152	0.00	0.0	0.0

Table 12, Quatsino Sound cont'd.

Survey	PFMA	SubArea	Transect No.	Linear Density (c/m-sh)		
				P. californicus	*C. miniata*	*C. pallida*
Quatsino Sound	27	11	153	0.00	0.0	0.0
Quatsino Sound	27	11	154	0.00	0.0	0.0
Quatsino Sound	27	11	155	0.00	0.0	0.0
Quatsino Sound	27	11	156	0.00	0.0	0.0
Quatsino Sound	27	11	157	0.00	--	--
Quatsino Sound	27	11	158	0.00	--	--

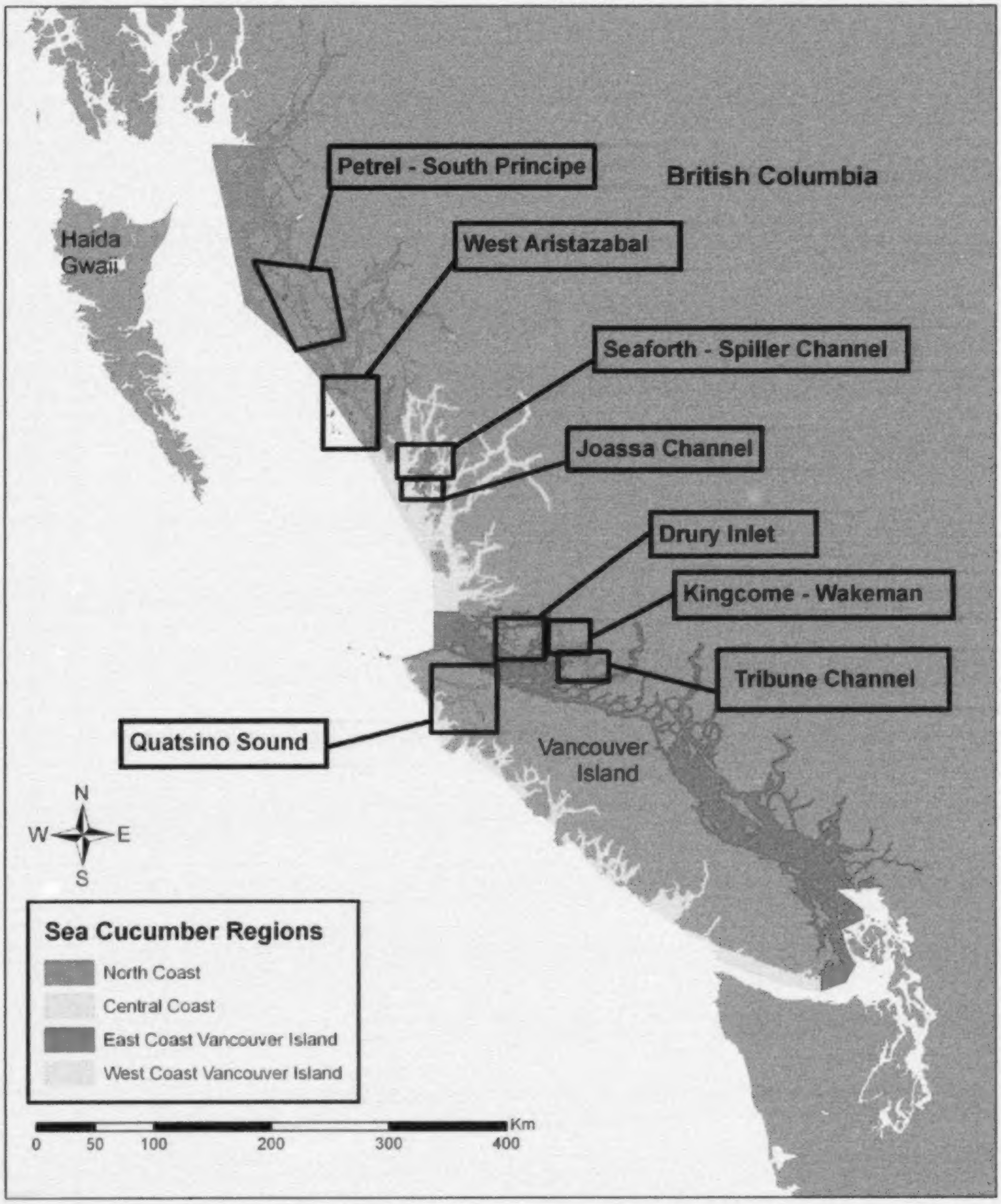
British Columbia
Petrel - South Principe
West Aristazabal
Haida Gwaii
Seaforth - Spiller Channel
Joassa Channel
Drury Inlet
Kingcome - Wakeman
Tribune Channel
Quatsino Sound
Vancouver Island
N
W
E
S
Sea Cucumber Regions
North Coast
Central Coast
East Coast Vancouver Island
West Coast Vancouver Island
Km
0
50
100
200
300
400

Figure 1. Sea cucumber surveys conducted June 2012 to May 2013. Open surveys were conducted in Petrel and South Principe, West Aristazabal, Seaforth – Spiller Channel, Joassa Channel, Tribune Channel, Drury Inlet, Kingcome – Wakeman and Quatsino Sound.

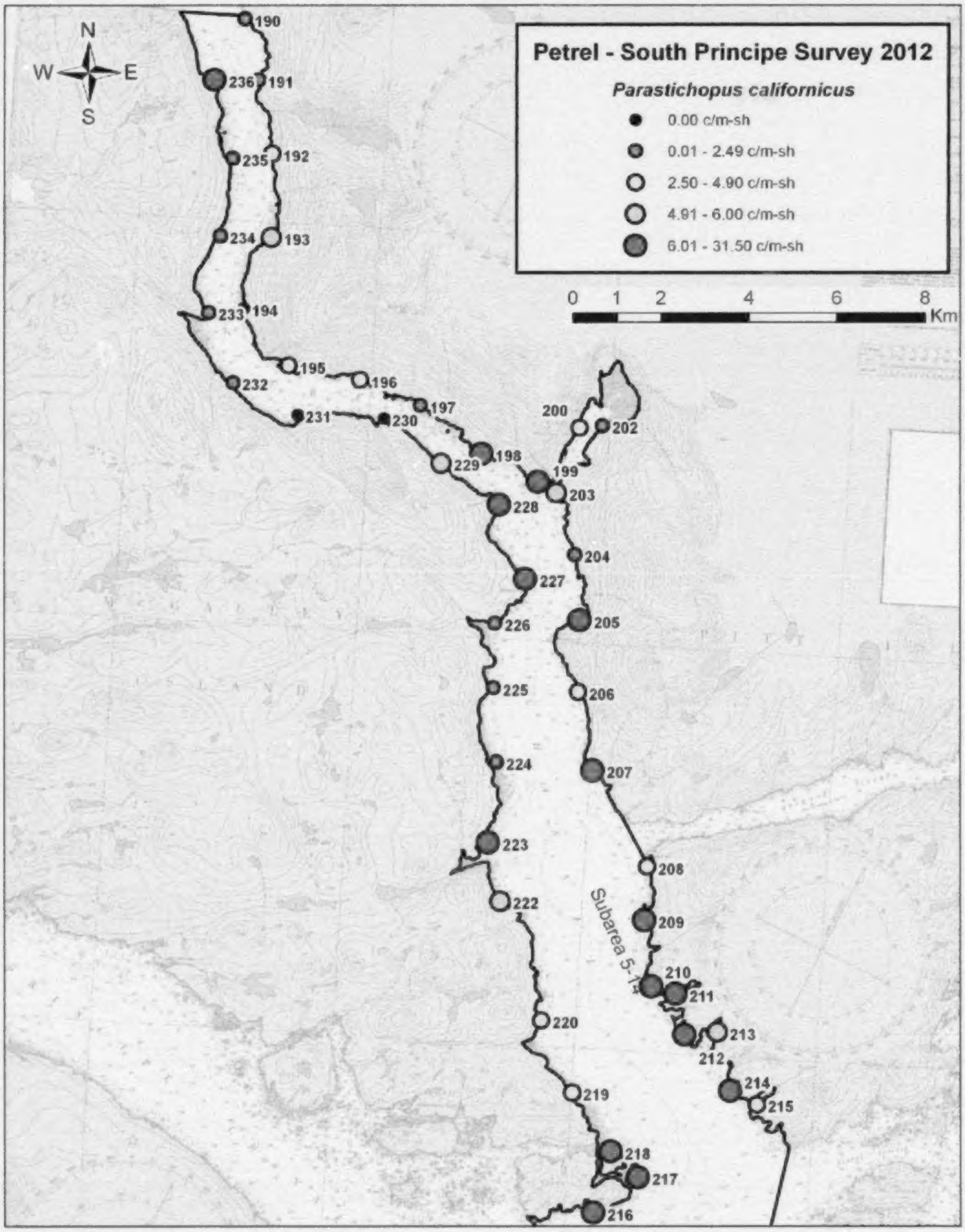
Petrel - South Principe Survey 2012
Parastichopus californicus
0.00 c/m-sh
0.01 - 2.49 c/m-sh
2.50 - 4.90 c/m-sh
4.91 - 6.00 c/m-sh
6.01 - 31.50 c/m-sh
0 1 2 4 6 8 Km
N
W
E
S
190
191
236
192
235
193
234
194
233
195
232
196
197
231
230
200
202
198
229
199
203
228
204
227
226
205
225
206
224
207
223
208
222
209
Subarea 5-1
210
211
220
213
212
214
215
219
218
217
216

Figure 2. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 5-14, surveyed as part of the Petrel-South Principe survey in 2012. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 c/m-sh and the bootstrapped lower 90% confidence bound calculated for the subarea); green = productive locations (densities between the bootstrapped lower 90% confidence bound and the Regional Baseline Density); blue = very productive locations (densities above the Regional Baseline Density).

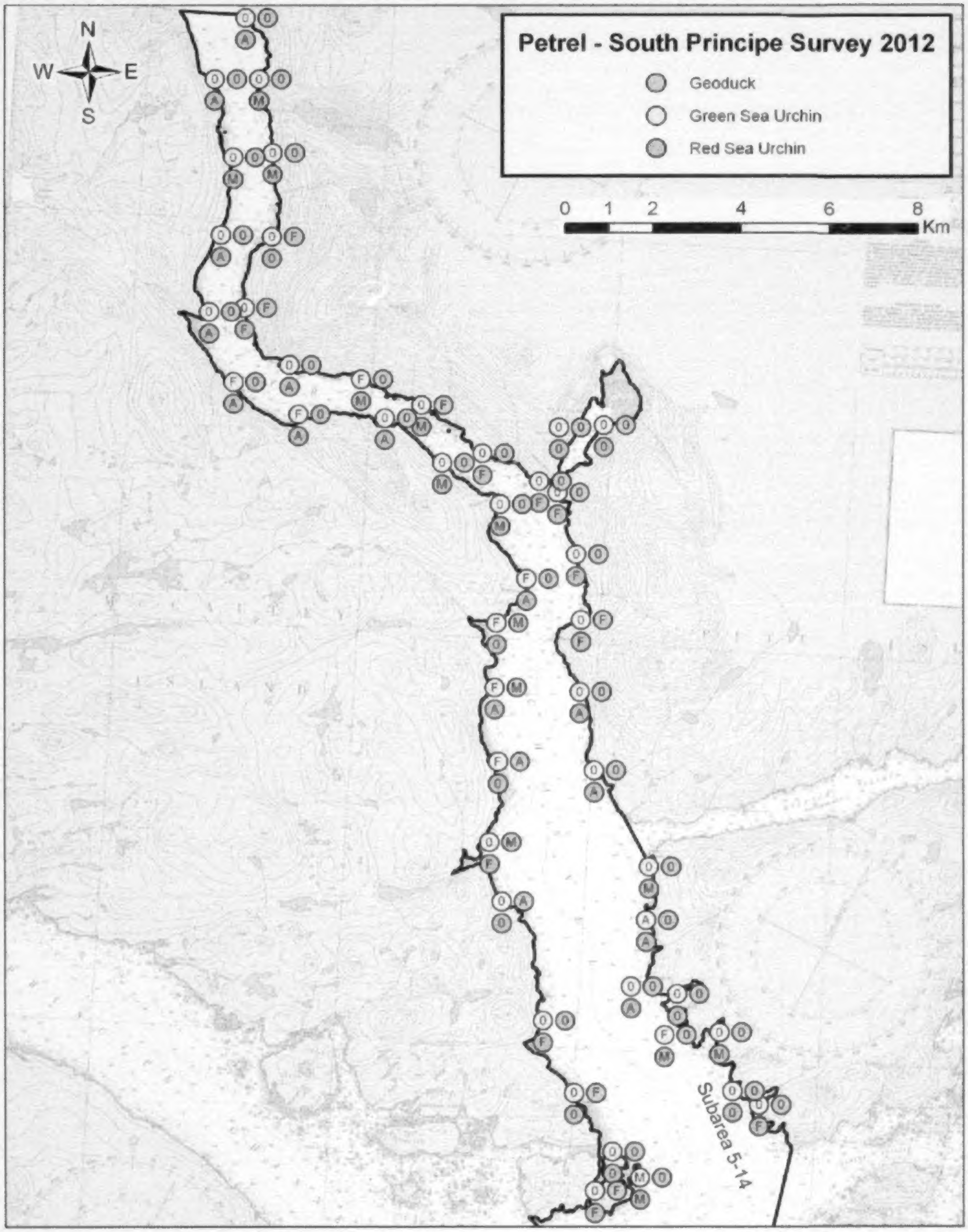
Petrel - South Principe Survey 2012
Geoduck
Green Sea Urchin
Red Sea Urchin
0
1
2
4
6
8
Km
N
S
W
E
Subarea 5-14
A
M
F
0

Figure 3. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 5-14. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); 0=zero animals.

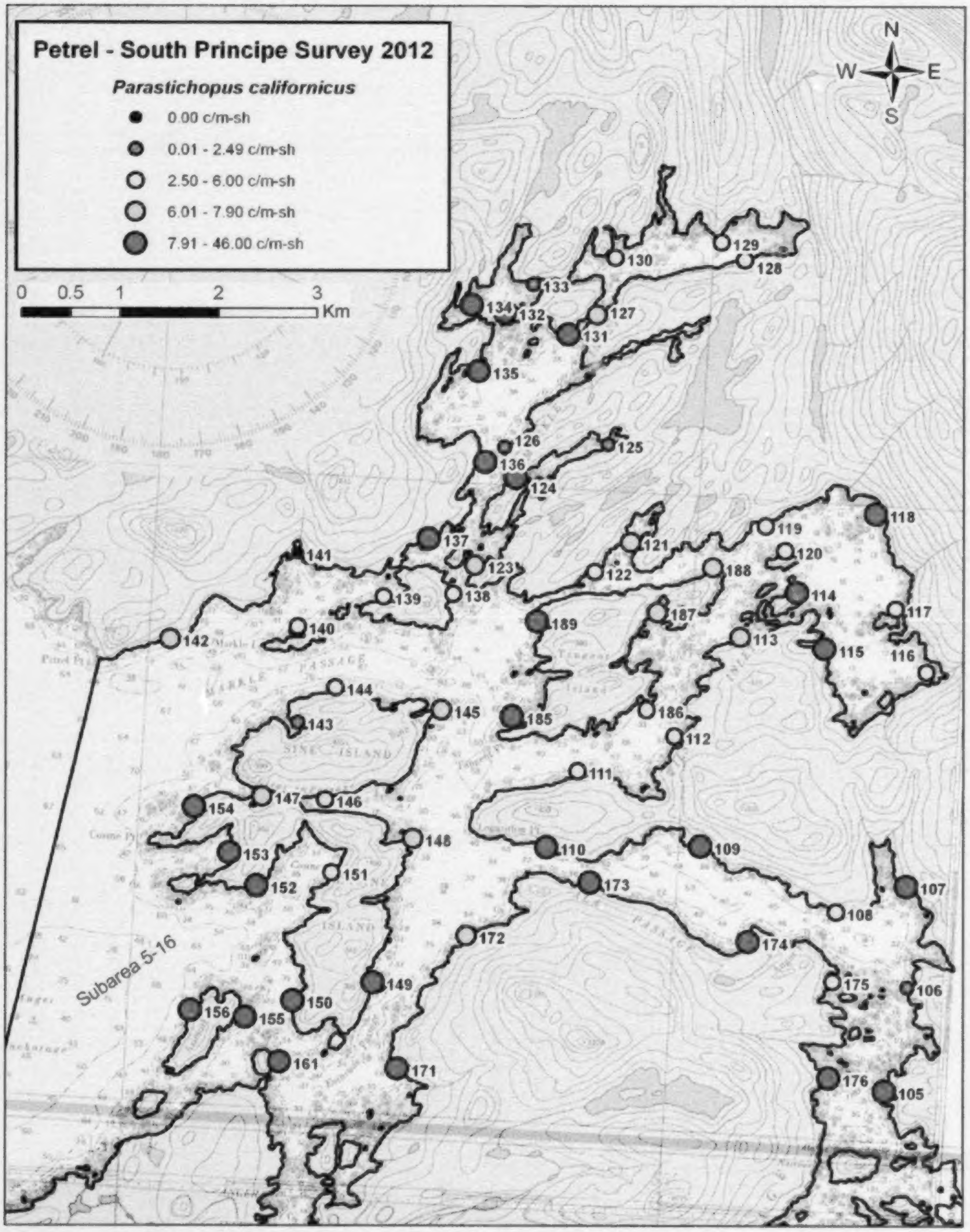
Petrel - South Principe Survey 2012
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 6.00 c/m-sh
○ 6.01 - 7.90 c/m-sh
● 7.91 - 46.00 c/m-sh
0 0.5 1 2 3 Km
N
W
E
S
Subarea 5-16
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
139
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156
161
171
172
173
174
175
176
185
186
187
188
189

Figure 4a. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 5-16, surveyed as part of the Petrel-South Principe survey in 2012. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 c/m-sh and Regional Baseline Density); green = productive locations (densities between the Regional Baseline Density and bootstrapped lower 90% confidence bound); blue = very productive locations (densities above the bootstrapped lower 90% confidence bound).

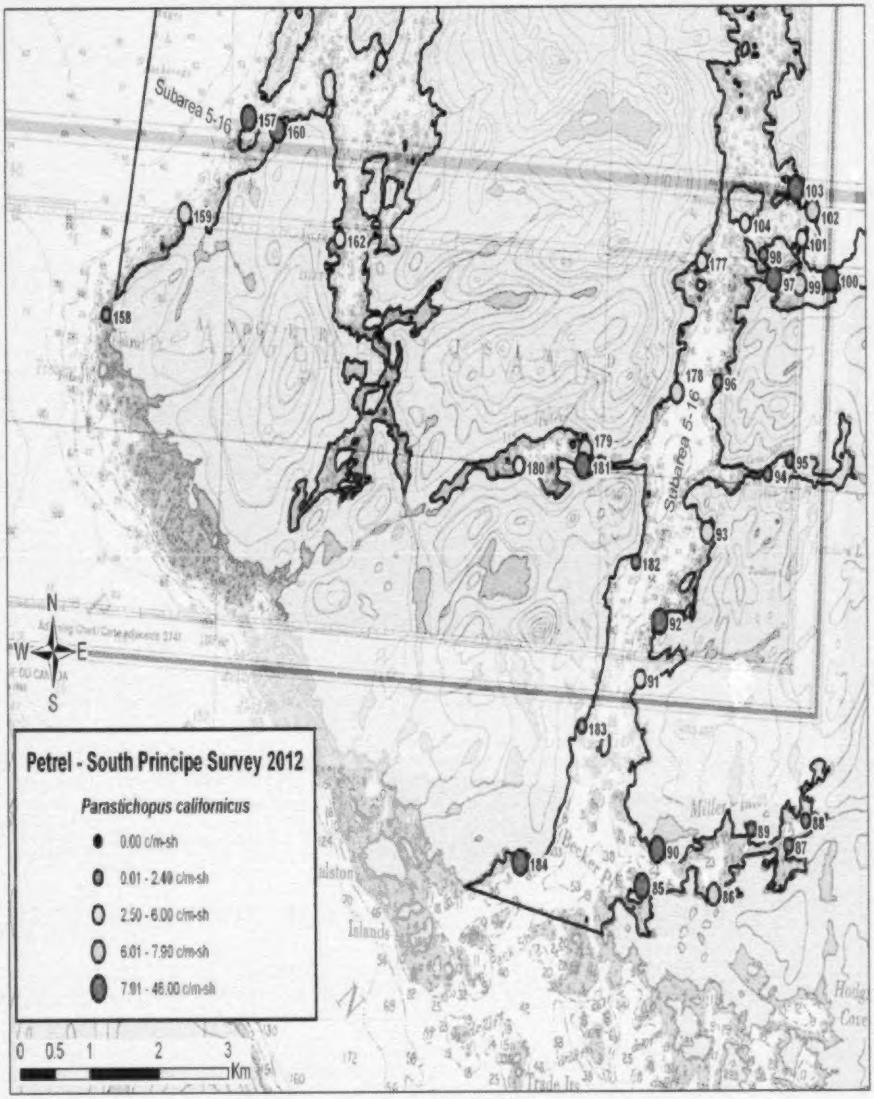
Subarea 5-16
157
160
159
162
158
177
103
102
104
101
98
97
99
100
178
96
179
180
181
95
94
93
182
92
91
183
184
90
89
88
87
85
86
N
W
E
S
Petrel - South Principe Survey 2012
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 6.00 c/m-sh
○ 6.01 - 7.90 c/m-sh
● 7.91 - 46.00 c/m-sh
0 0.5 1 2 3 Km

Figure 4b. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 5-16, surveyed as part of the Petrel-South Principe survey in 2012. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 c/m-sh and Regional Baseline Density); green = productive locations (densities between the Regional Baseline Density and bootstrapped lower 90% confidence bound); blue = very productive locations (densities above the bootstrapped lower 90% confidence bound).

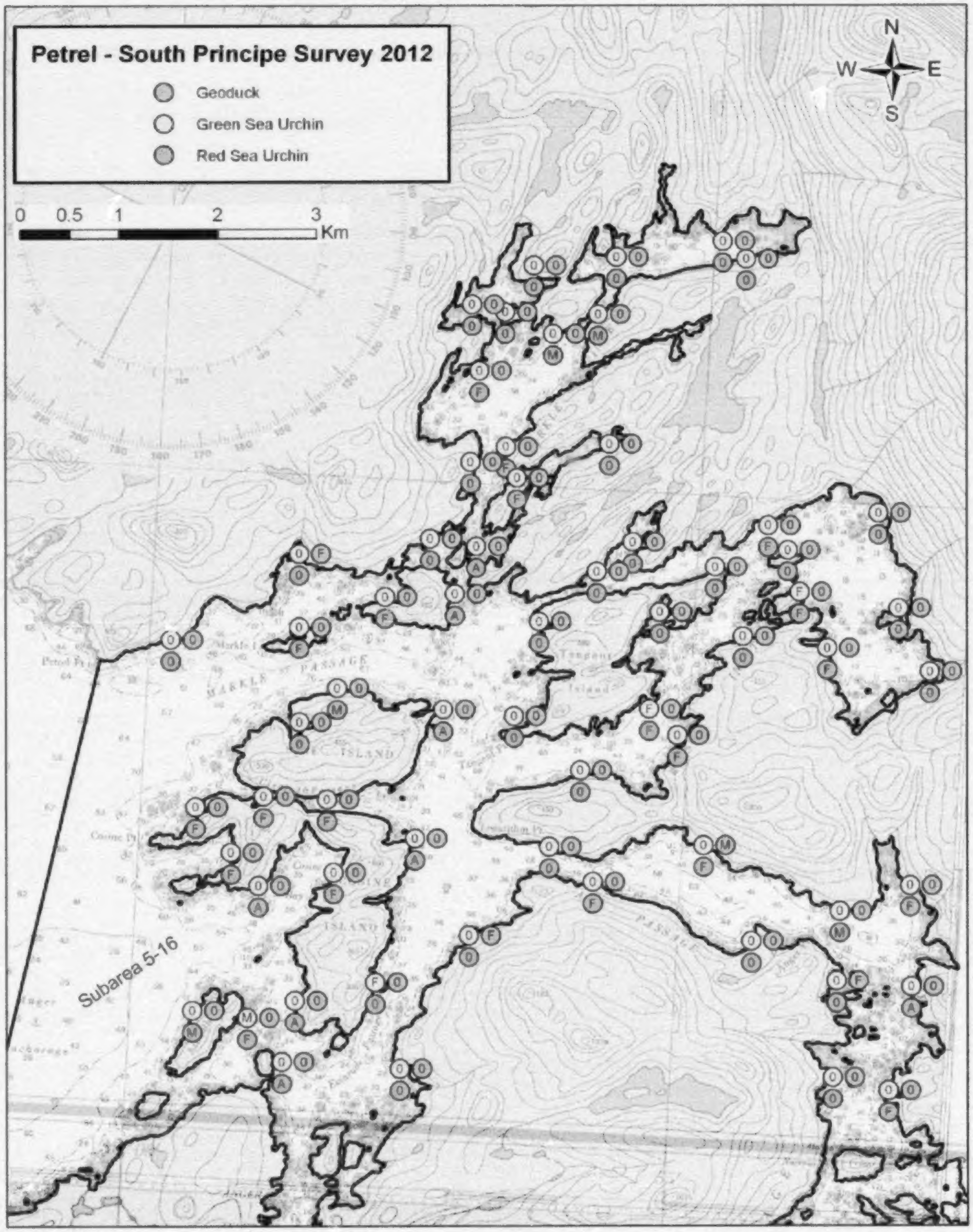
Petrel - South Principe Survey 2012
Geoduck
Green Sea Urchin
Red Sea Urchin
0 0.5 1 2 3 Km
N
W
E
S
MARKLE PASSAGE
ISLAND
Petrel Pt
Subarea 5-16

Figure 5a. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 5-16. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); 0=zero animals.

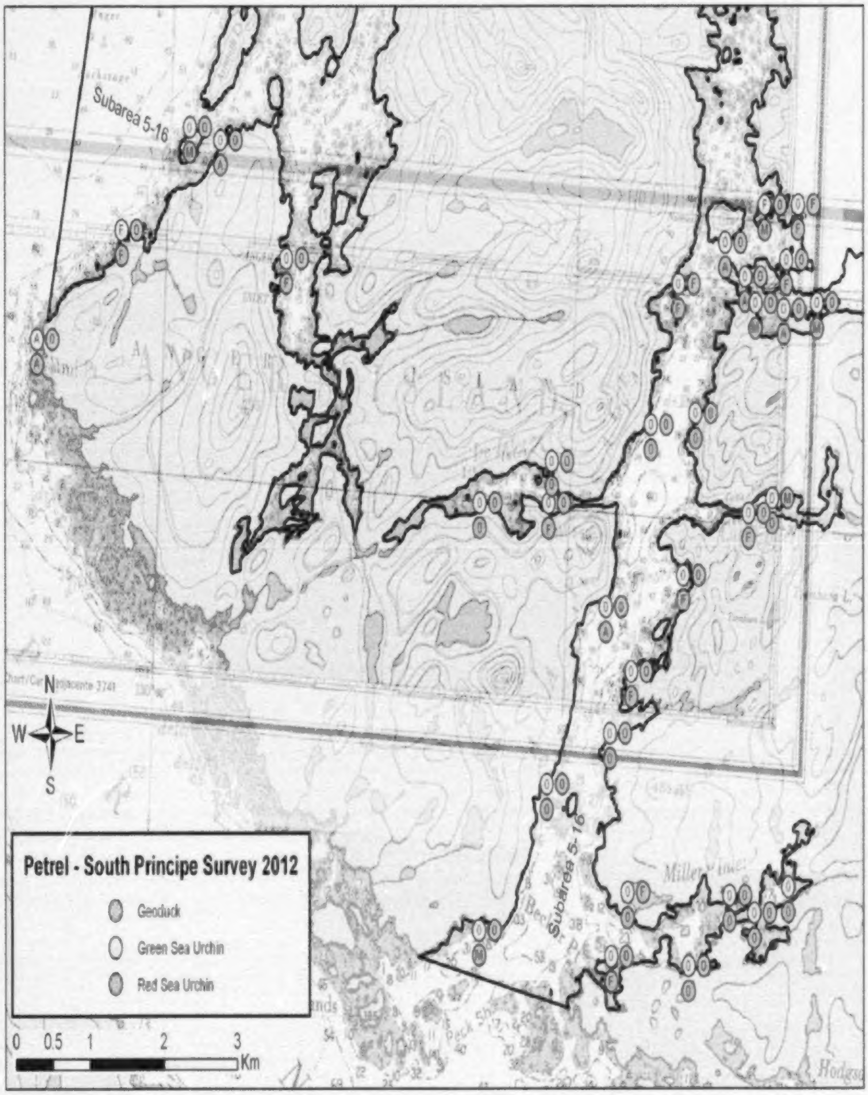
Subarea 5-16
N
W
E
S
Petrel - South Principe Survey 2012
Geoduck
Green Sea Urchin
Red Sea Urchin
0
0.5
1
2
3
Km
Miller Inlet
Subarea 5-16

Figure 5b. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in part of PFMA 5-16. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); 0=zero animals.

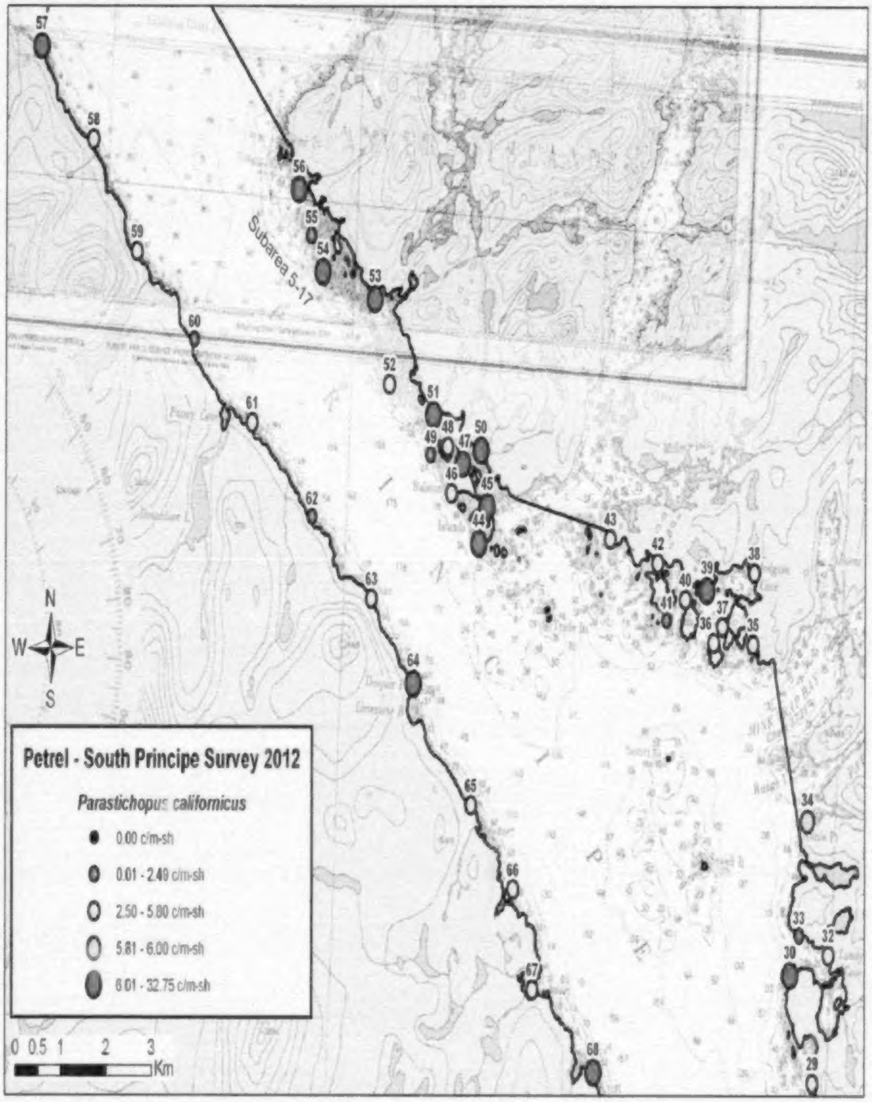
Petrel - South Principe Survey 2012
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 5.80 c/m-sh
○ 5.81 - 6.00 c/m-sh
● 6.01 - 32.75 c/m-sh
Subarea 5-17
N
W
E
S
0 0.5 1 2 3 Km
57
58
59
60
61
62
63
64
65
66
67
68
56
55
54
53
52
51
50
49
48
47
46
45
44
43
42
41
40
39
38
37
36
35
34
33
32
30
29

Figure 6a. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 5-17, surveyed as part of the Petrel-South Principe survey in 2012. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 c/m-sh and the lower 90% confidence bound for the Subarea); green = productive locations (between the lower 90% confidence bound calculated for the Subarea and the Regional Baseline Density); blue = very productive locations (densities above the Regional Baseline Density).

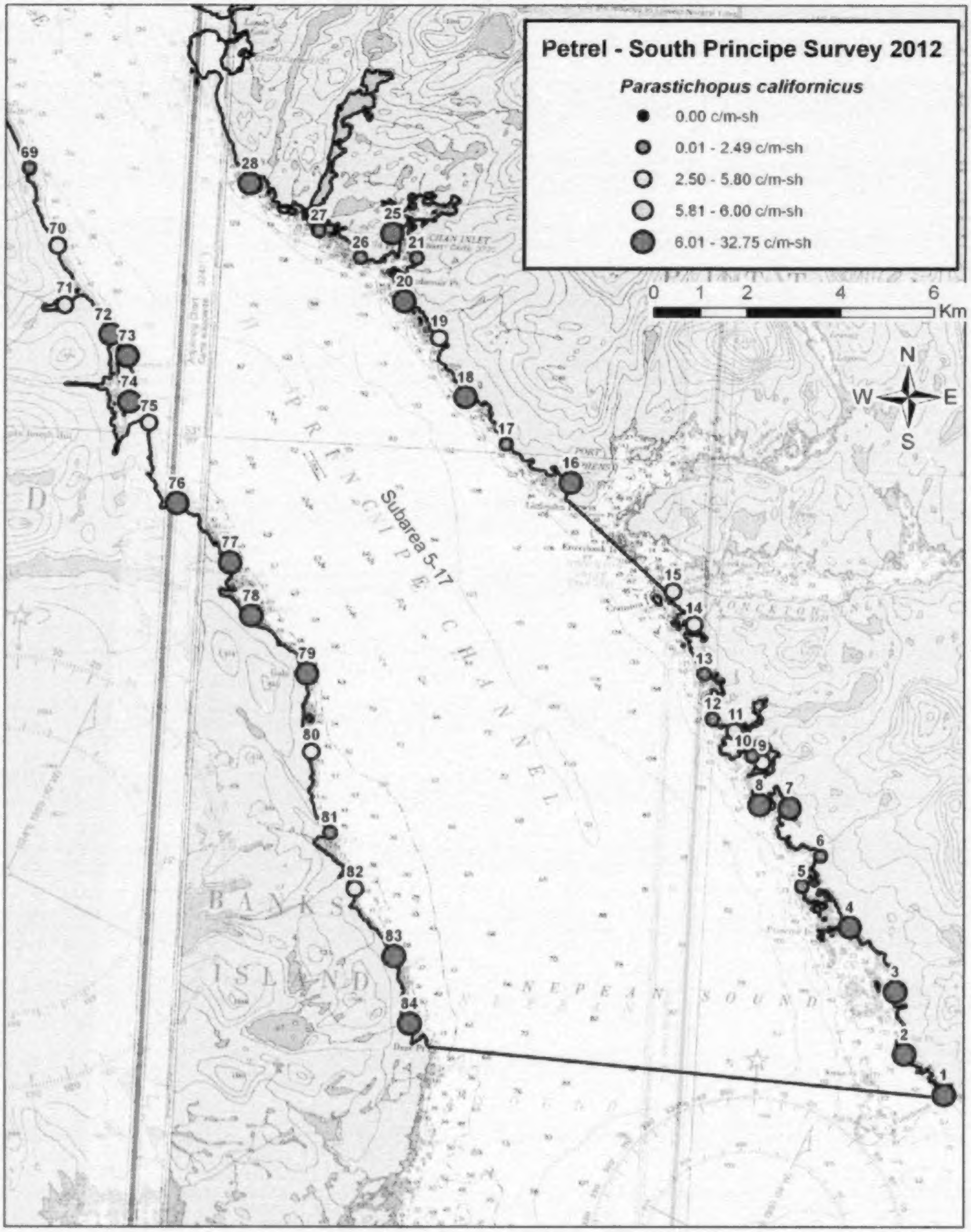
Petrel - South Principe Survey 2012
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 5.80 c/m-sh
○ 5.81 - 6.00 c/m-sh
● 6.01 - 32.75 c/m-sh
0
1
2
4
6
Km
N
W
E
S
Subarea 5-17
PRINCIPE CHANNEL
BANKS ISLAND
NEPEAN SOUND
69
70
71
72
73
74
75
76
77
78
79
80
81
82
83
84
28
27
26
25
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1

Figure 6b. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of ***Parastichopus californicus*** in PFMA 5-17, surveyed as part of the Petrel-South Principe survey in 2012. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 c/m-sh and the lower 90% confidence bound for the Subarea); green = productive locations (between the lower 90% confidence bound calculated for the Subarea and the Regional Baseline Density); blue = very productive locations (densities above the Regional Baseline Density).

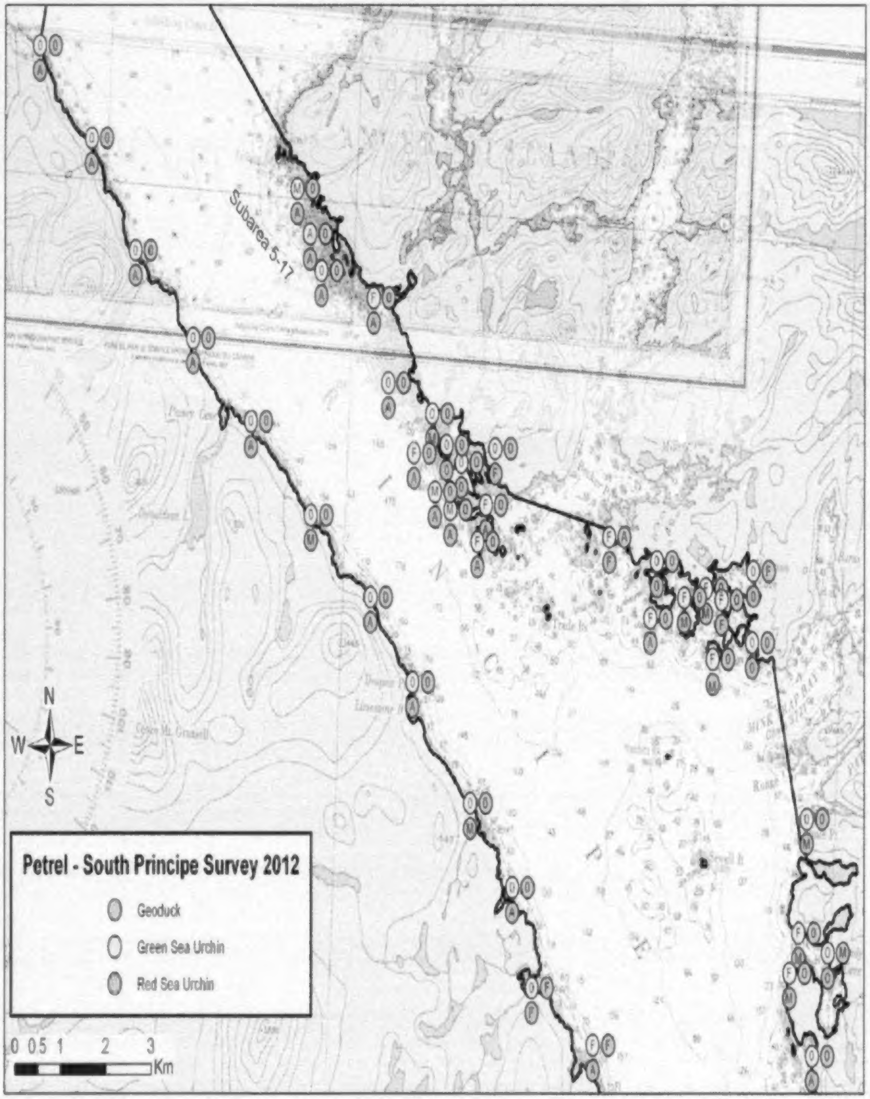
Subarea 5-17
N
W
E
S
Petrel - South Principe Survey 2012
Geoduck
Green Sea Urchin
Red Sea Urchin
0 0.5 1 2 3
Km

Figure 7a. Relative abundance of Red Sea Urchin, Green Sea urchin and Geoduck on transects surveyed for sea cucumber in a portion of PFMA 5-17. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); 0=zero animals.

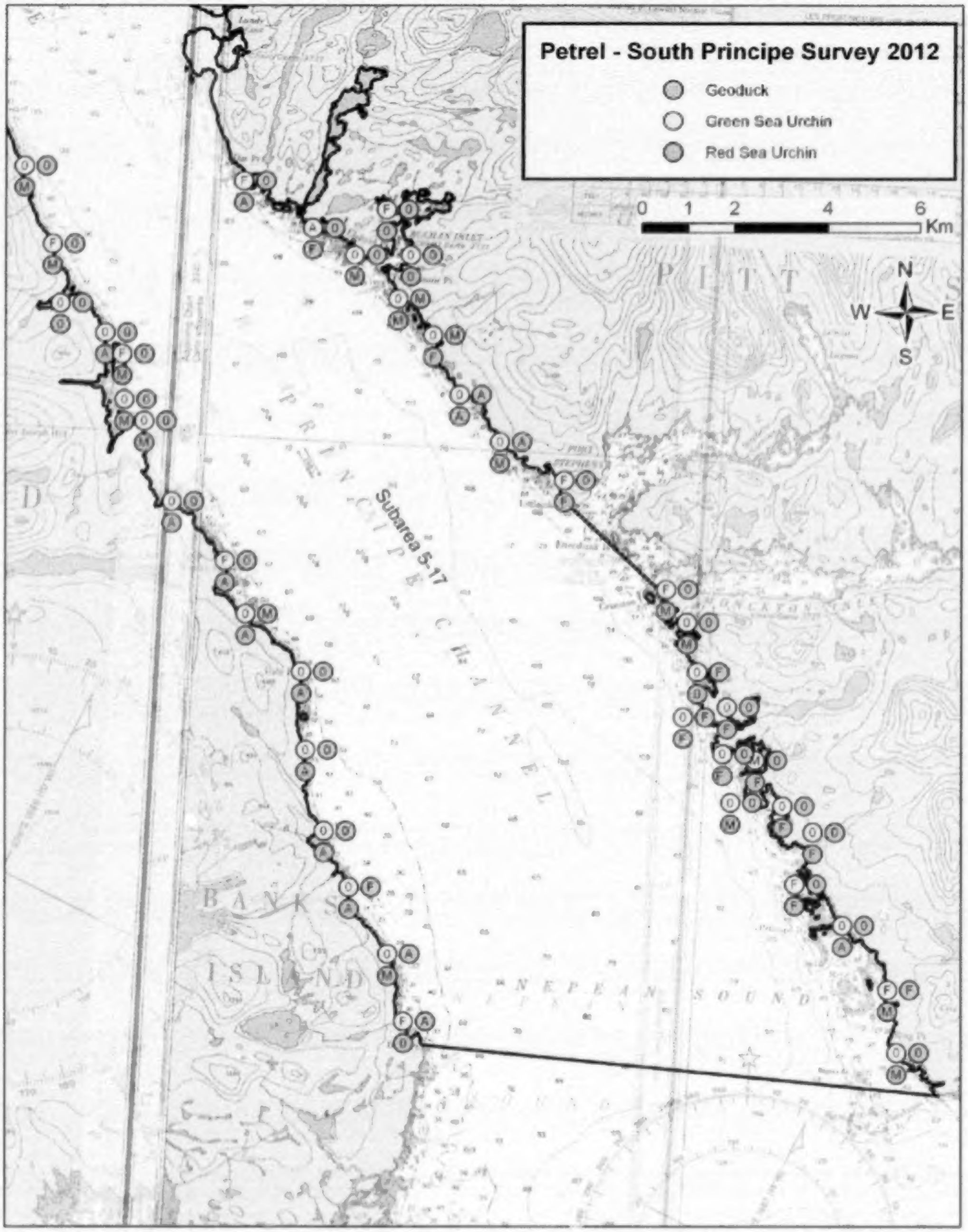
Petrel - South Principe Survey 2012
Geoduck
Green Sea Urchin
Red Sea Urchin
0 1 2 4 6 Km
N
W
E
S
PITT
Subarea 5-17
PRINCIPE CHANNEL
BANKS ISLAND
NEPEAN SOUND
A
M
F
0

Figure 7b. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in a portion of PFMA 5-17. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); 0=zero animals.

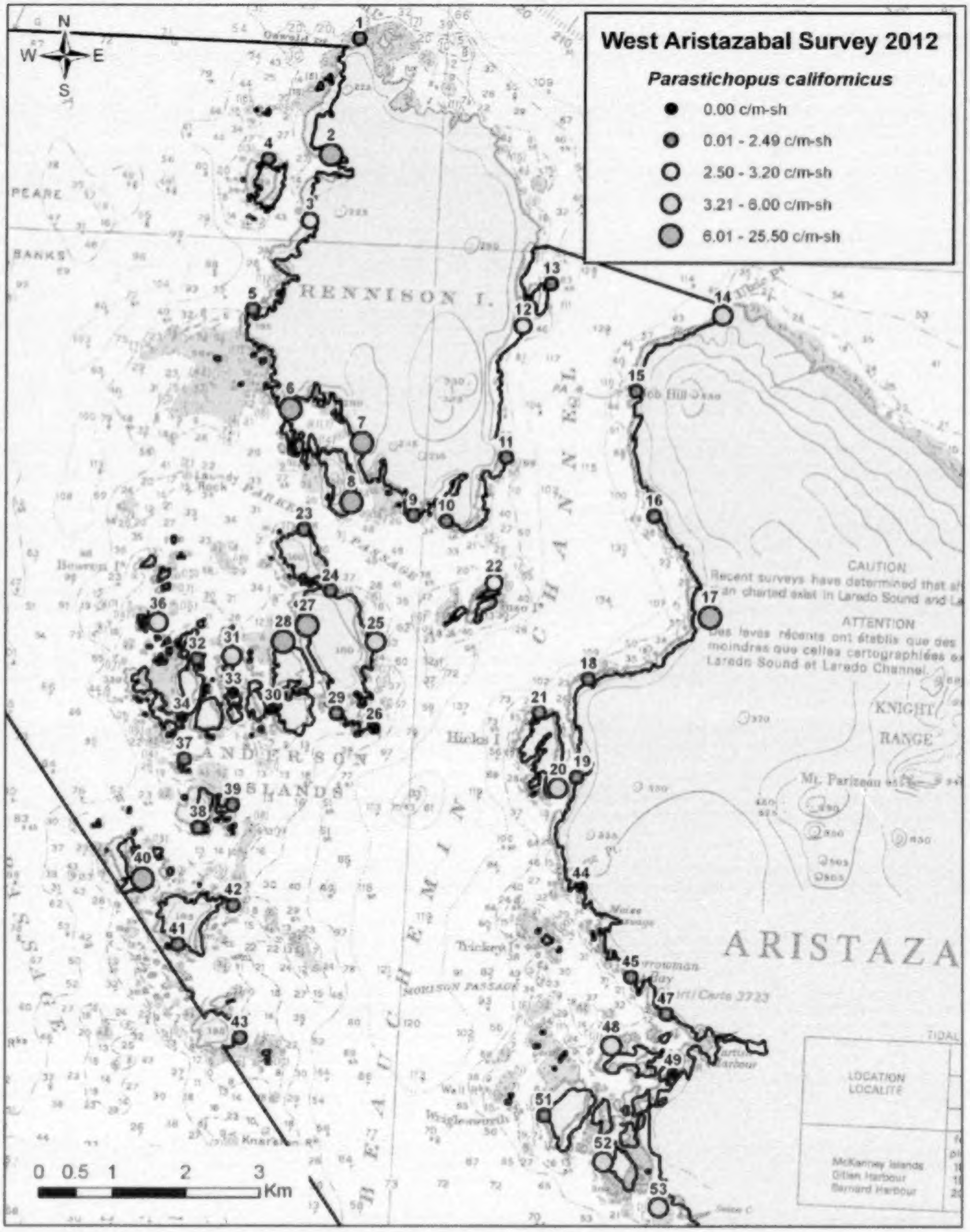
West Aristazabal Survey 2012
Parastichopus californicus
0.00 c/m-sh
0.01 - 2.49 c/m-sh
2.50 - 3.20 c/m-sh
3.21 - 6.00 c/m-sh
6.01 - 25.50 c/m-sh
N
S
W
E
RENNISON I.
ANDERSON ISLANDS
ARISTAZA
KNIGHT RANGE
0 0.5 1 2 3 Km

Figure 8a. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of ***Parastichopus californicus*** in northern portions of PFMA 6-13, surveyed as part of the West Aristazabal survey in 2012. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 c/m-sh and 90% lower confidence bound calculated for the Subarea); green = productive locations (between 3.21 c/m-sh and the Regional Baseline Density); blue = very productive locations (densities above the Regional Baseline Density).

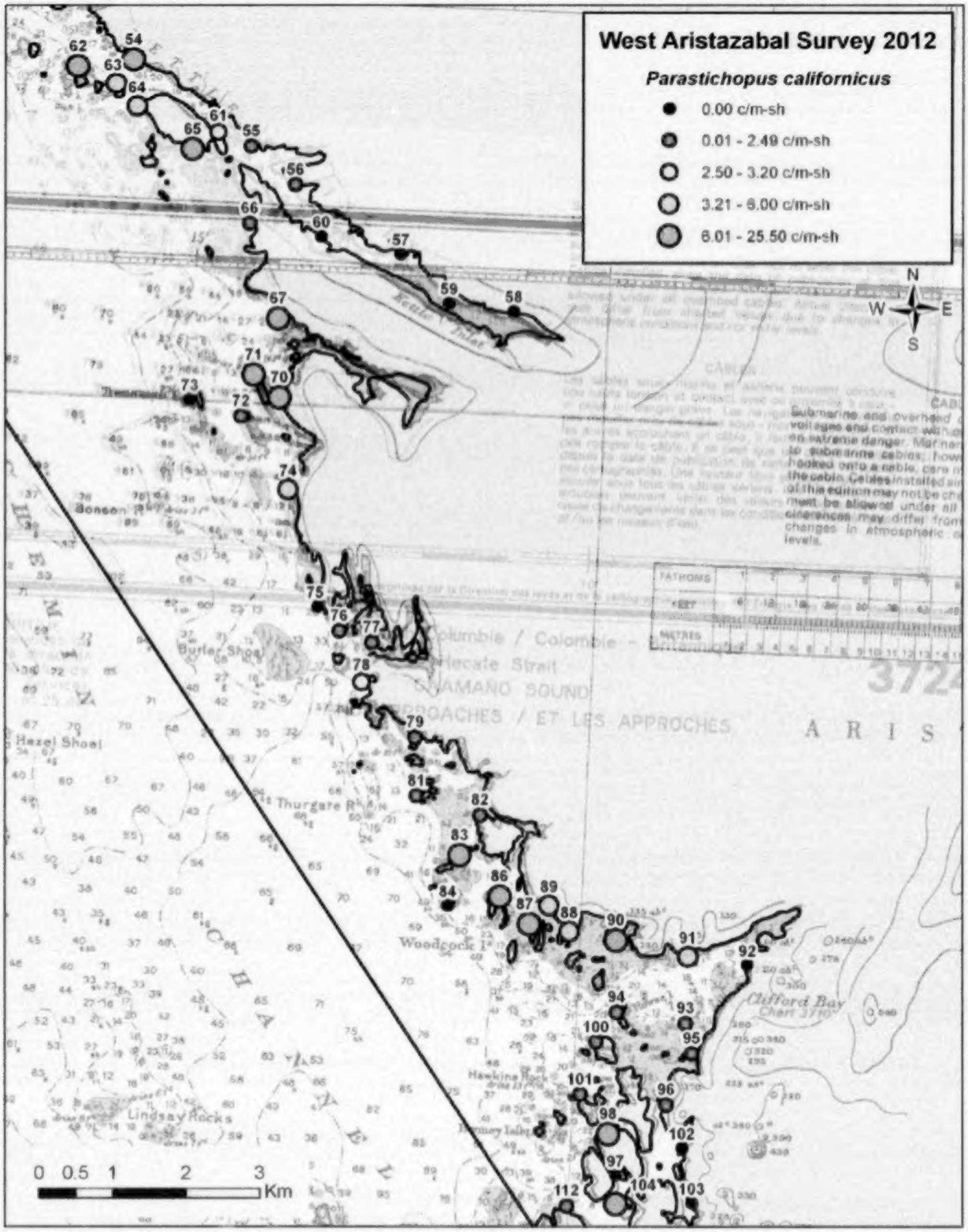
West Aristazabal Survey 2012
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 3.20 c/m-sh
○ 3.21 - 6.00 c/m-sh
○ 6.01 - 25.50 c/m-sh
N
W
E
S
0 0.5 1 2 3 Km
54
55
56
57
58
59
60
61
62
63
64
65
66
67
70
71
72
73
74
75
76
77
78
79
81
82
83
84
86
87
88
89
90
91
92
93
94
95
96
97
98
100
101
102
103
104
112
Butler Shoal
Hazel Shoal
Thurgate R
Woodcock I
Hawkins Rock
Lindsay Rocks
Clifford Bay
A R I S

Figure 8b. **Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 6-13, surveyed as part of the West Aristazabal survey in 2012. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 c/m-sh and the 90% lower confidence bound); green = productive locations (between 3.21 c/m-sh and the Regional Baseline Density); blue = very productive locations (densities above the Regional Baseline Density).**

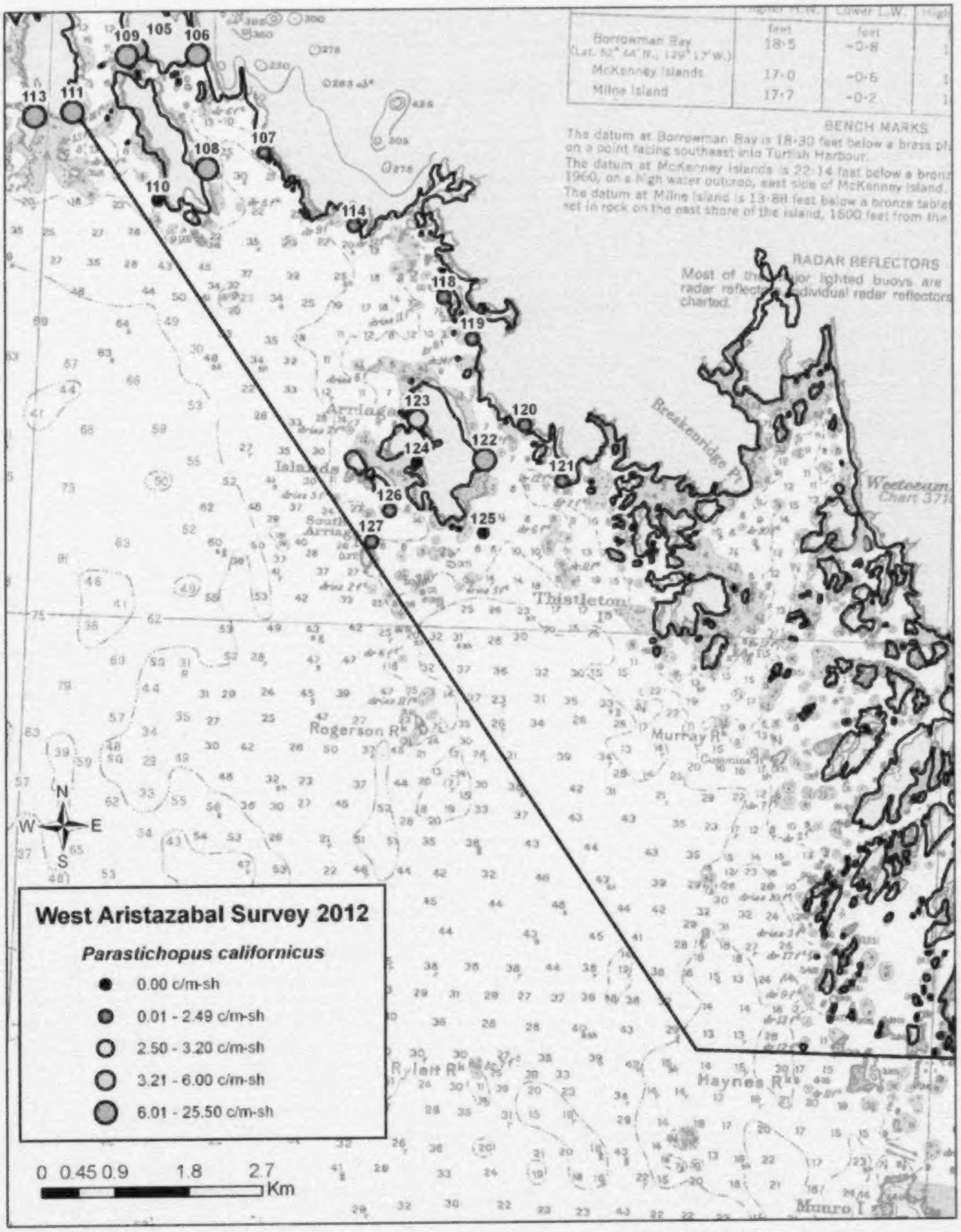
West Aristazabal Survey 2012
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 3.20 c/m-sh
○ 3.21 - 6.00 c/m-sh
○ 6.01 - 25.50 c/m-sh
0 0.45 0.9 1.8 2.7 Km
N
S
E
W
105
106
107
108
109
110
111
113
114
118
119
120
121
122
123
124
125
126
127
Borrowman Bay
McKenney Islands
Milne Island
BENCH MARKS
RADAR REFLECTORS
Arriaga Islands
South Arriaga
Thistleton Is
Rogerson Rk
Murray Rk
Haynes Rks
Breckenridge Pt
Munro I

Figure 8c. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 6-13, surveyed as part of the West Aristazabal survey in 2012. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 c/m-sh and the 90% lower confidence bound); green = productive locations (between 3.21 c/m-sh and the Regional Baseline Density); blue = very productive locations (densities above the Regional Baseline Density).

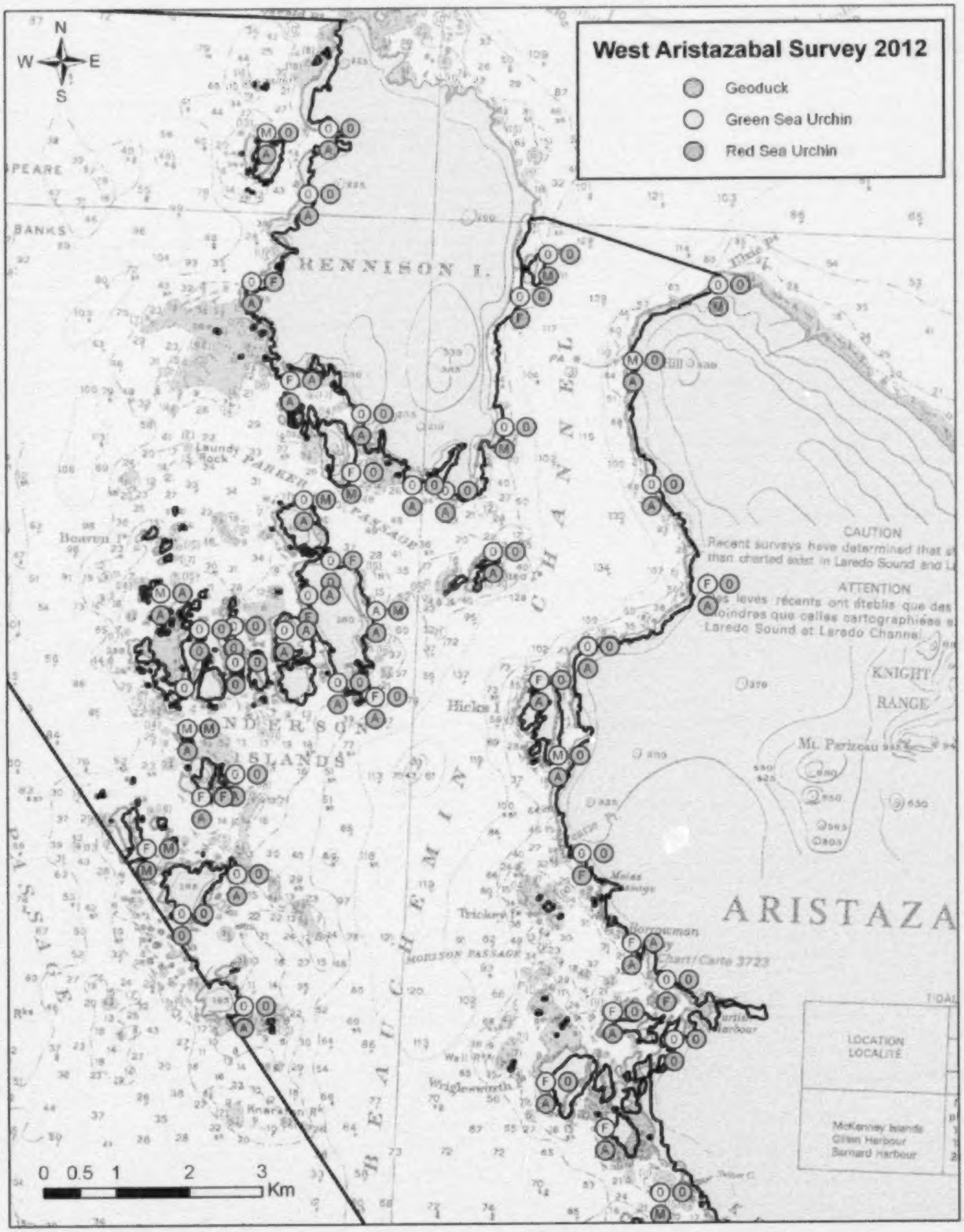
West Aristazabal Survey 2012
● Geoduck
○ Green Sea Urchin
● Red Sea Urchin
N
W
E
S
RENNISON I.
PARKER PASSAGE
ANDERSON ISLANDS
Hicks I.
Laundy Rock
Trickey I.
MORISON PASSAGE
Borrowman Bay
Wriglesworth
Knarston Rk
BEAUCHEMIN CHANNEL
ARISTAZA
KNIGHT RANGE
Mt. Parizeau
CAUTION
Recent surveys have determined that s than charted exist in Laredo Sound and L
ATTENTION
Des levés récents ont établis que des moindres que celles cartographiées s Laredo Sound et Laredo Channel
Chart/Carte 3723
LOCATION LOCALITÉ
McKenney Islands
Clifton Harbour
Barnard Harbour
0 0.5 1 2 3 Km

Figure 9a. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 6-13. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); 0=zero animals.

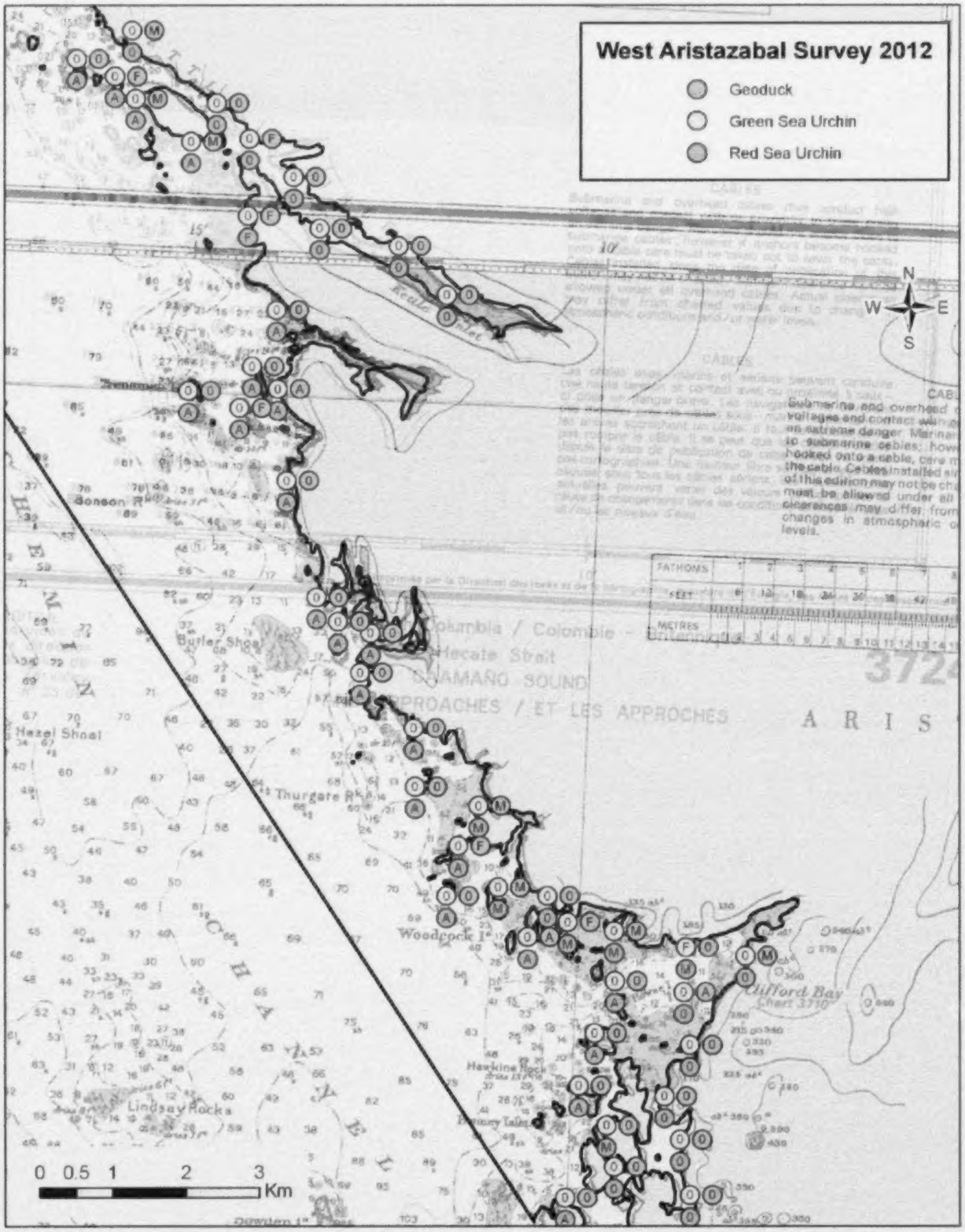
West Aristazabal Survey 2012
Geoduck
Green Sea Urchin
Red Sea Urchin
N
W
E
S
0 0.5 1 2 3 Km
Butler Shoal
Thurgate Rk
Woodcock I
Hawkins Rock
Lindsay Rocks
Hazel Shoal
Benson R
Clifford Bay
Hecate Strait
A R I S

Figure 9b. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 6-13. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); 0=zero animals.

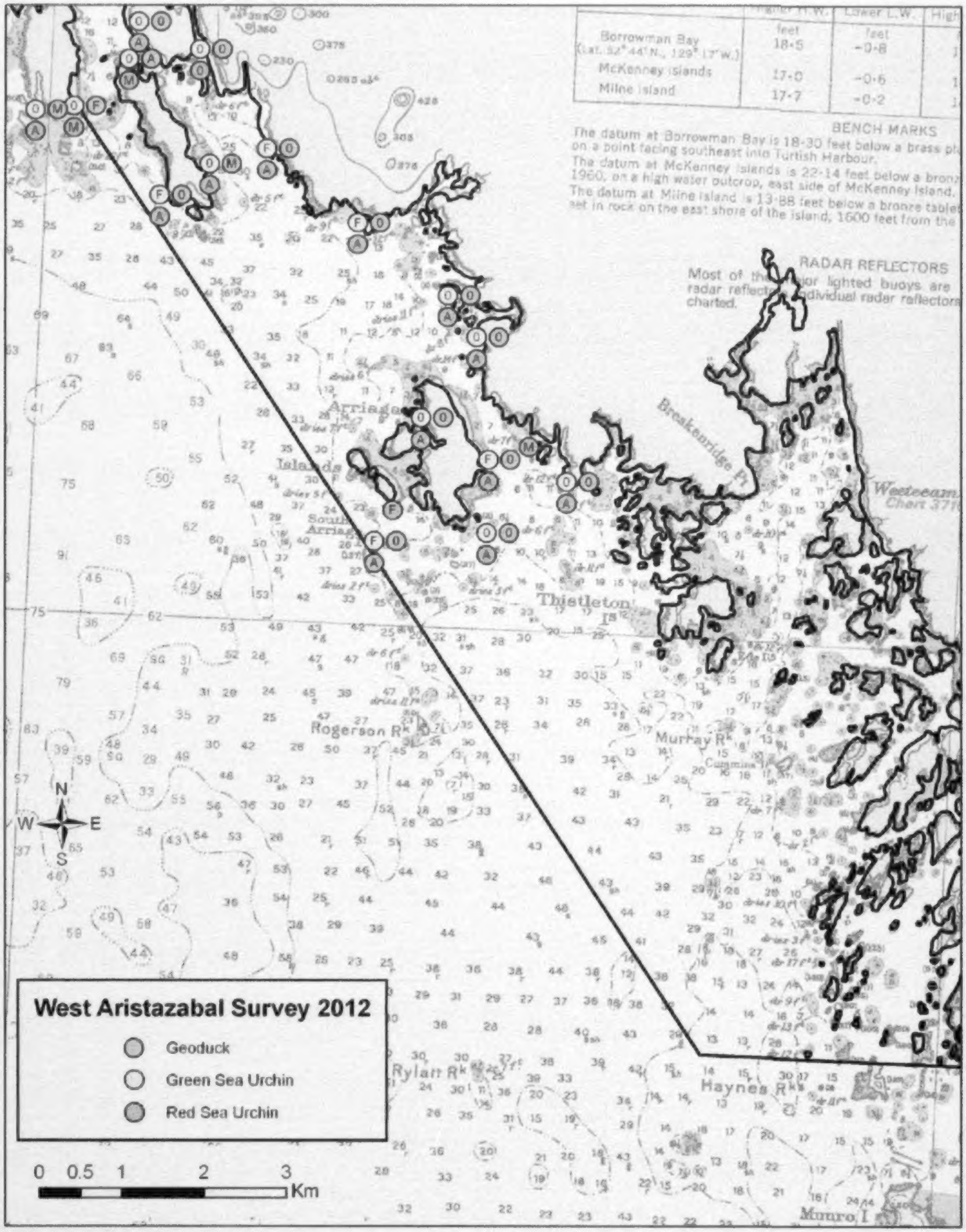
West Aristazabal Survey 2012
Geoduck
Green Sea Urchin
Red Sea Urchin
0 0.5 1 2 3 Km
N
E
S
W
Borrowman Bay
McKenney Islands
Milne Island
BENCH MARKS
RADAR REFLECTORS
Arriaga Islands
South Arriaga
Thistleton Is
Breakenridge Pt
Rogerson Rk
Murray Rk
Rylatt Rk
Haynes Rks
Munro I
A
M
F
0

Figure 9c. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 6-13. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); 0=zero animals.

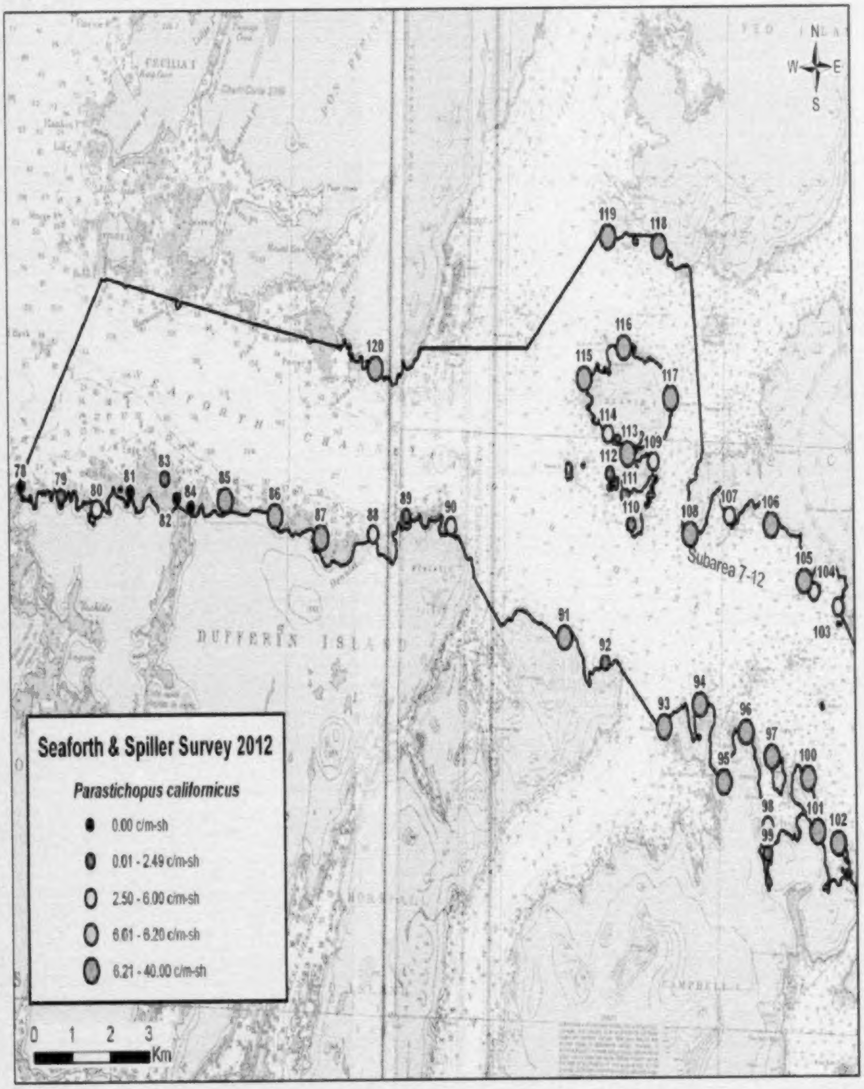
Seaforth & Spiller Survey 2012
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 6.00 c/m-sh
○ 6.01 - 6.20 c/m-sh
● 6.21 - 40.00 c/m-sh
N
W
E
S
0 1 2 3 Km
Subarea 7-12
DUFFERIN ISLAND
SEAFORTH CHANNEL
78
79
80
81
82
83
84
85
86
87
88
89
90
91
92
93
94
95
96
97
98
99
100
101
102
103
104
105
106
107
108
109
110
111
112
113
114
115
116
117
118
119
120

Figure 10. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 7-12, surveyed as part of the Seaforth-Spiller Channel survey in 2012. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.50 c/m-sh and the Regional Baseline Density); green = productive locations (between the Regional Baseline Density and the lower 90% confidence bound calculated for the Subarea); blue = very productive locations (densities above the lower 90% confidence bound).

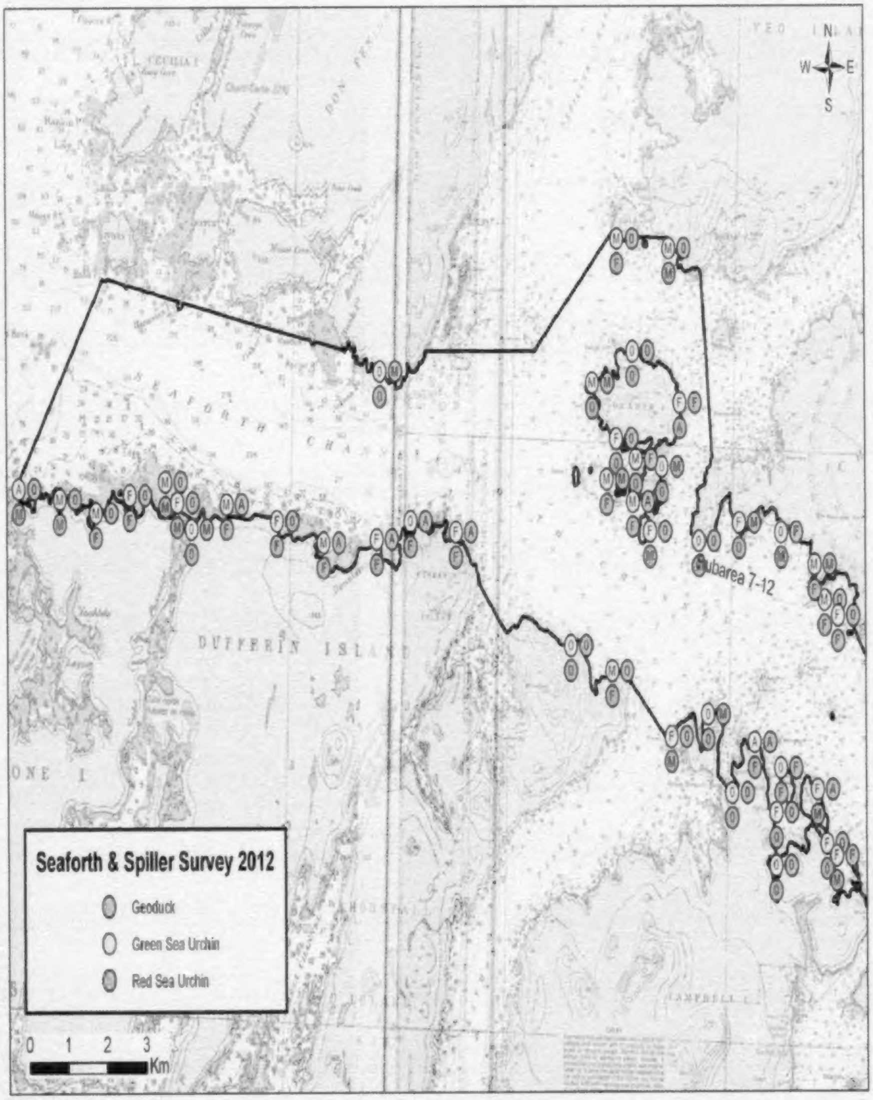
N
W
E
S
SEAFORTH CHANNEL
DUFFERIN ISLAND
Subarea 7-12
Seaforth & Spiller Survey 2012
Geoduck
Green Sea Urchin
Red Sea Urchin
0 1 2 3
Km

Figure 11. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 7-12. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); 0=zero animals.

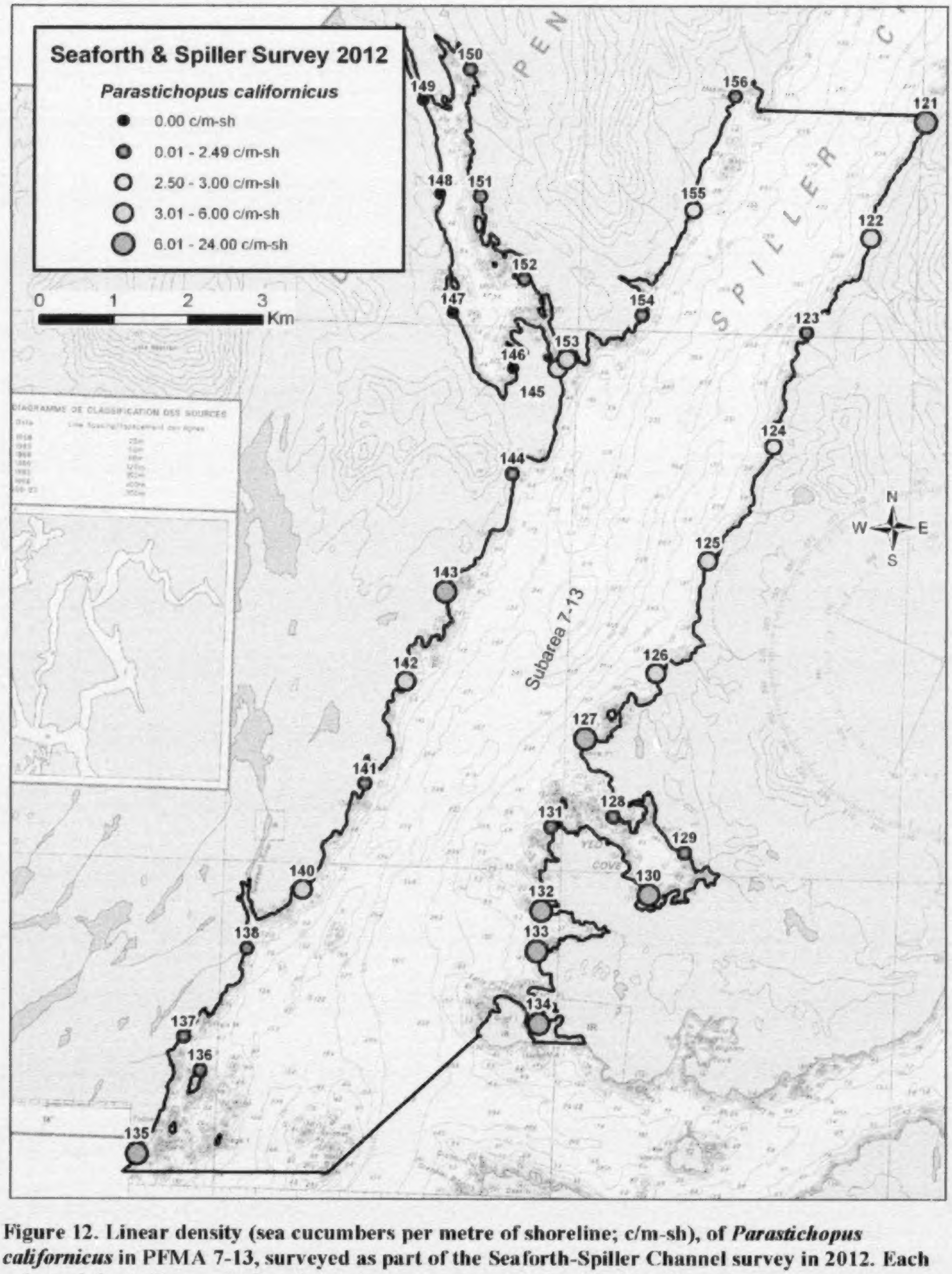
Seaforth & Spiller Survey 2012
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 3.00 c/m-sh
○ 3.01 - 6.00 c/m-sh
○ 6.01 - 24.00 c/m-sh
0 1 2 3 Km
N
W
E
S
Subarea 7-13
121
122
123
124
125
126
127
128
129
130
131
132
133
134
135
136
137
138
140
141
142
143
144
145
146
147
148
149
150
151
152
153
154
155
156

Figure 12. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of ***Parastichopus californicus*** in PFMA 7-13, surveyed as part of the Seaforth-Spiller Channel survey in 2012. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 c/m-sh and the bootstrapped lower 90% confidence bound calculated for the Subarea); green = productive locations (between the bootstrapped lower 90% confidence bound and the Regional Baseline Density); blue = very productive locations (densities above the Regional Baseline Densities).

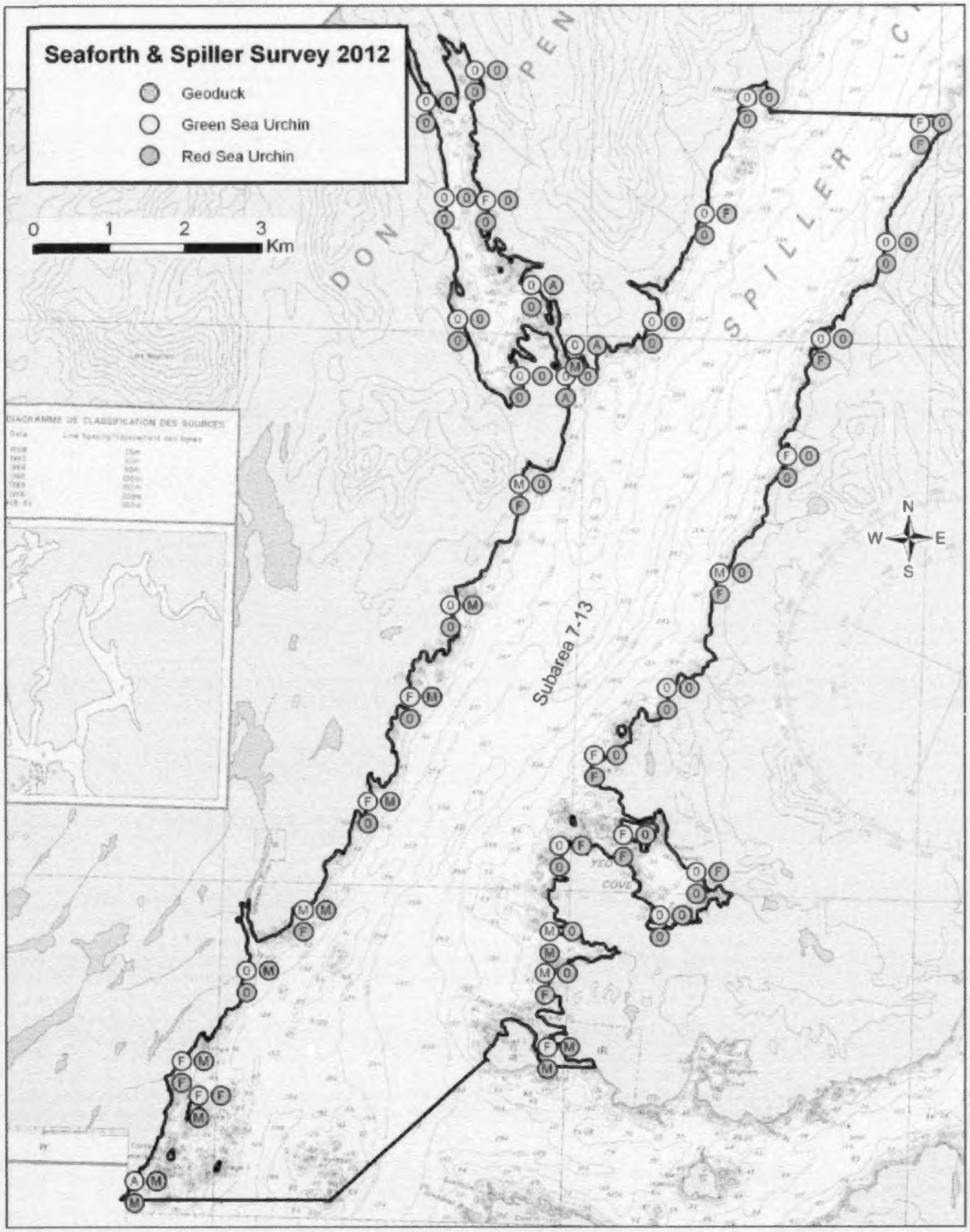
Seaforth & Spiller Survey 2012
Geoduck
Green Sea Urchin
Red Sea Urchin
0 1 2 3 Km
N
W
E
S
Subarea 7-13
SPILLER
DON PEN
YEO COVE

Figure 13. Abundances of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 7-13. The total number of animals observed while swimming the transect is noted and given an abundance scale of A, M, F, or 0. A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); 0=zero animals.

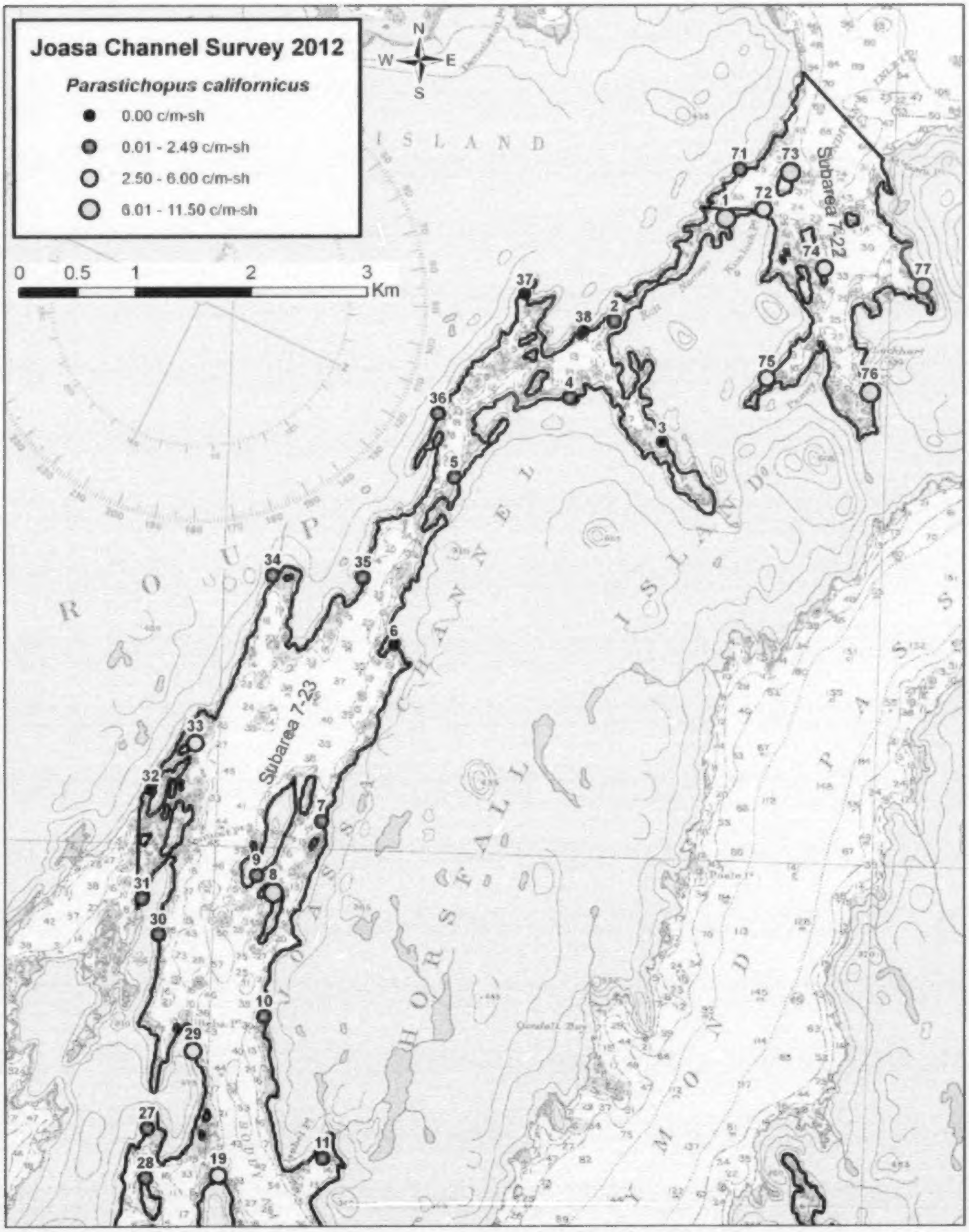
Joasa Channel Survey 2012
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 6.00 c/m-sh
○ 6.01 - 11.50 c/m-sh
0
0.5
1
2
3
Km
N
W
E
S
Subarea 7-22
Subarea 7-23
1
2
3
4
5
6
7
8
9
10
11
19
27
28
29
30
31
32
33
34
35
36
37
38
71
72
73
74
75
76
77
ISLAND

Figure 14a. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 7-22 & 7-23, surveyed as part of the Joassa Channel survey in 2012. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 c/m-sh and the bootstrapped lower 90% confidence bound); green = productive locations (between the bootstrapped lower 90% confidence bound and the Regional Baseline Density); blue = very productive locations (densities above the Regional Baseline Density).

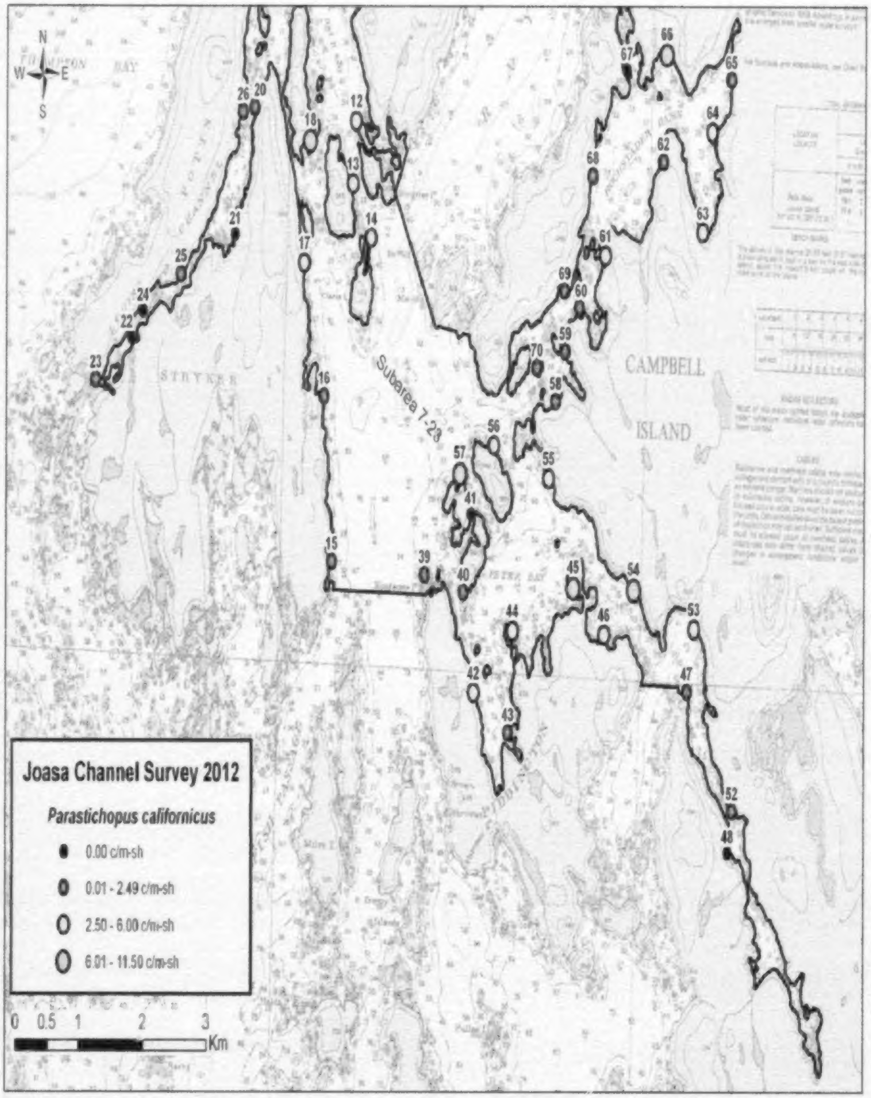
N
W
E
S
Joasa Channel Survey 2012
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 6.00 c/m-sh
○ 6.01 - 11.50 c/m-sh
0 0.5 1 2 3
Km
Subarea 7-28
CAMPBELL
ISLAND
12
13
14
15
16
17
18
20
21
22
23
24
25
26
39
40
41
42
43
44
45
46
47
48
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70

Figure 14b. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 7-22 & 7-23, surveyed as part of the Joassa Channel survey in 2012. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 c/m-sh and the bootstrapped lower 90% confidence bound); green = productive locations (between the bootstrapped lower 90% confidence and the Regional Baseline Density); blue = very productive locations (densities above the Regional Baseline Density).

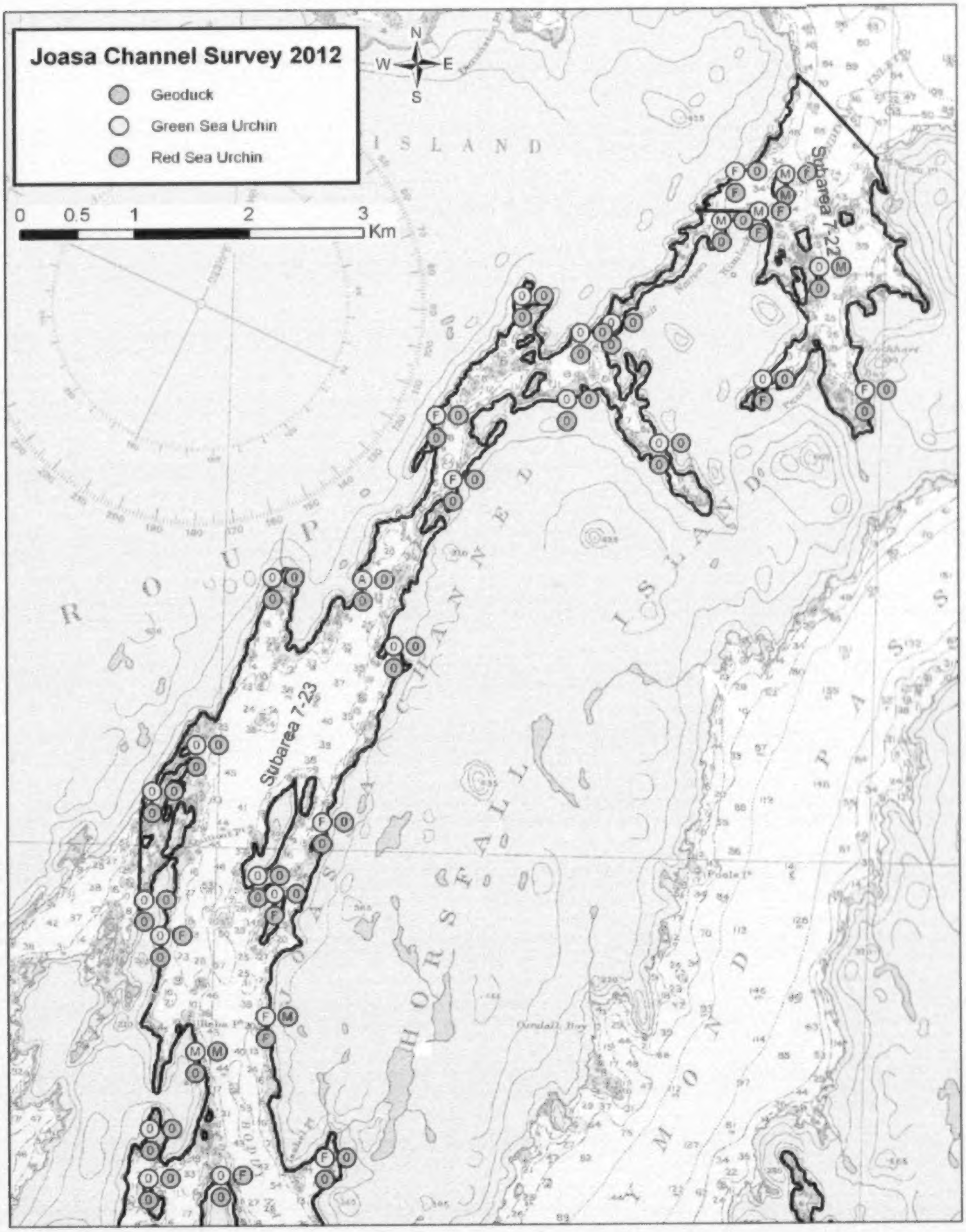
Joasa Channel Survey 2012
Geoduck
Green Sea Urchin
Red Sea Urchin
0
0.5
1
2
3
Km
N
W
E
S
Subarea 7-22
Subarea 7-23
ISLAND
R O U P
HORSFALL ISLAND
CHANNEL
MOND PASS
A
M
F
0

Figure 15a. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 7-22 & 7-23. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); 0=zero animals.

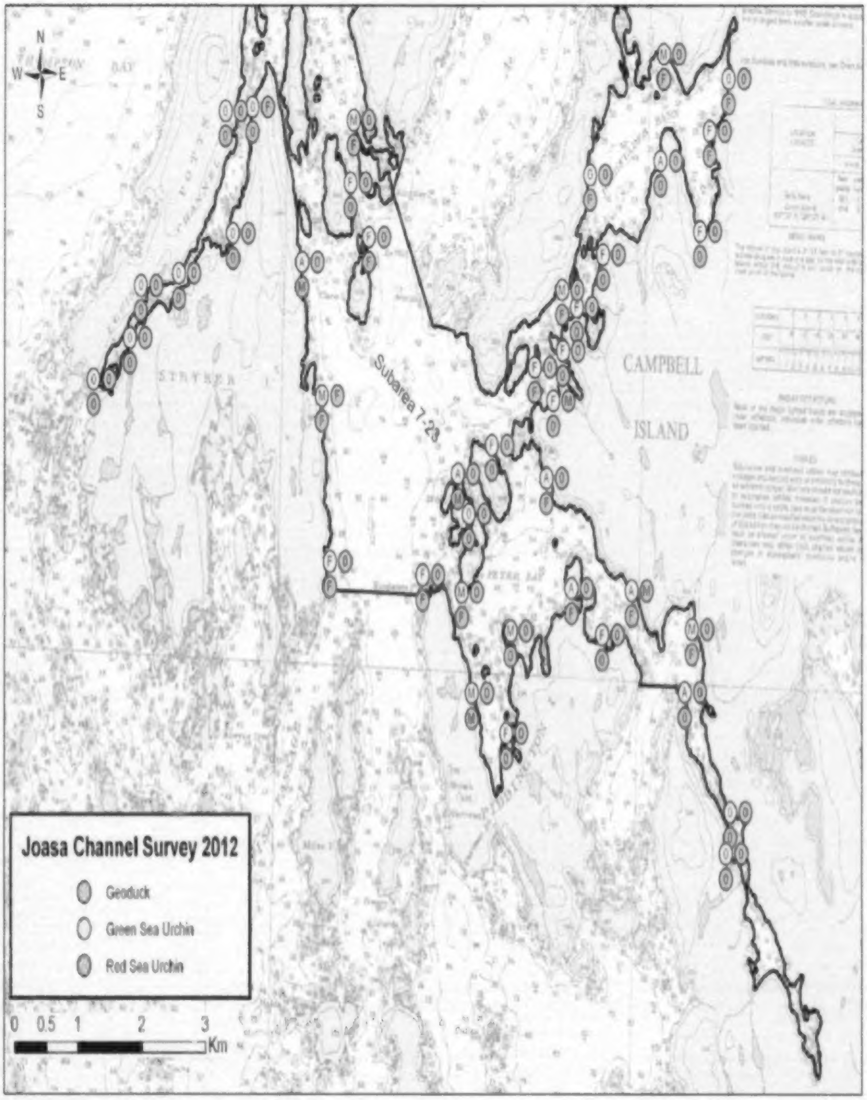
N
W
E
S
CAMPBELL
ISLAND
Subarea 7-23
STRYKER I.
Joasa Channel Survey 2012
Geoduck
Green Sea Urchin
Red Sea Urchin
0 0.5 1 2 3
Km

Figure 15b. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 7-22 & 7-23. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); 0=zero animals.

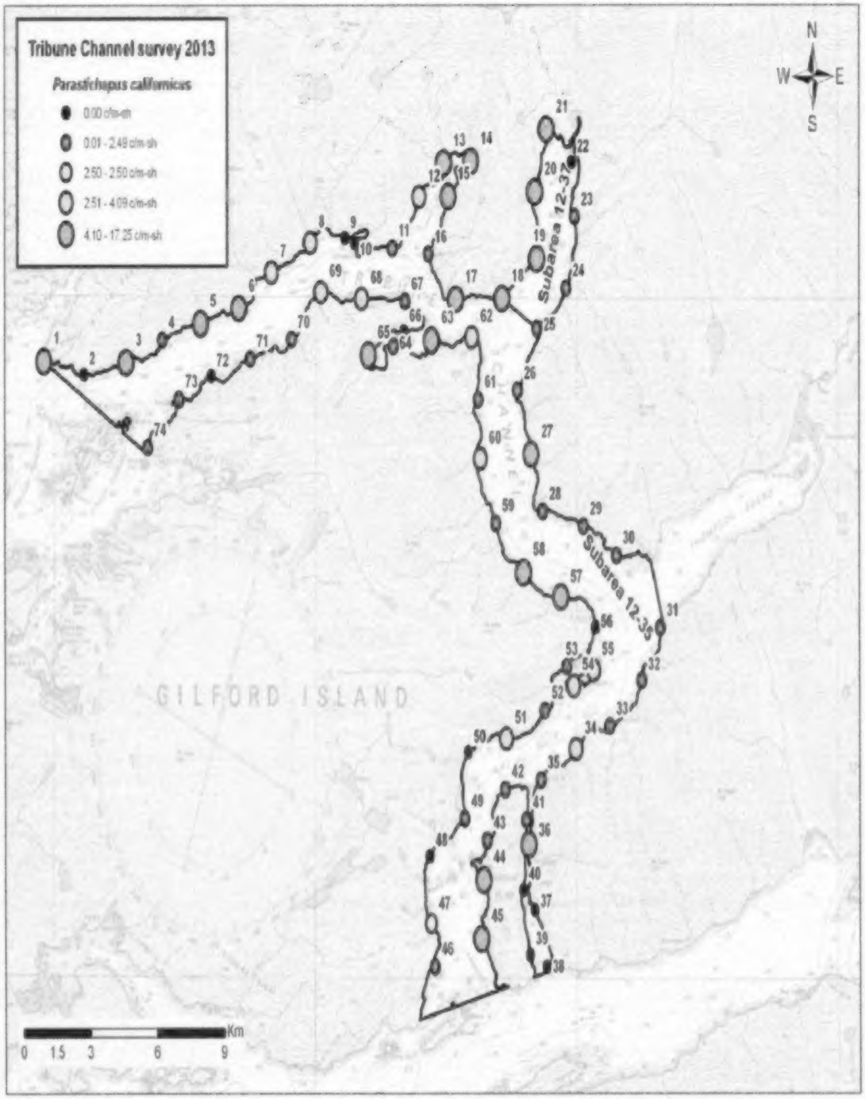
Tribune Channel survey 2013
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 2.50 c/m-sh
○ 2.51 - 4.09 c/m-sh
● 4.10 - 17.25 c/m-sh
N
W
E
S
Subarea 12-37
Subarea 12-35
GILFORD ISLAND
Km
0
1.5
3
6
9
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68
69
70
71
72
73
74

Figure 16. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* PFMA 12-35 & 12-37, surveyed as part of the Tribune Channel survey in 2013. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (densities of 2.5 c/m-sh which equals the 90% lower confidence bound calculated for the Subareas); green = productive locations (between 2.51 c/m-sh and the Regional Baseline Density); blue = very productive locations (densities above Regional Baseline Density).

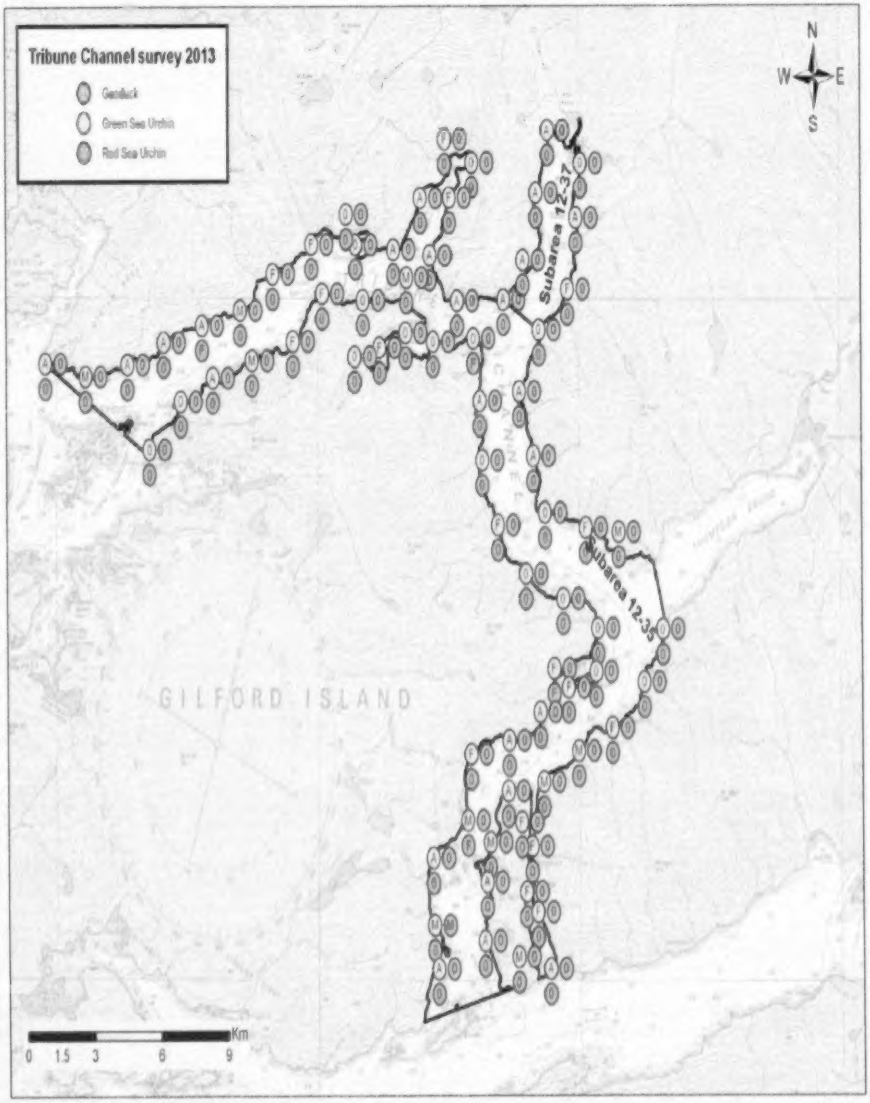
Tribune Channel survey 2013
Geoduck
Green Sea Urchin
Red Sea Urchin
N
W
E
S
Subarea 12-37
Subarea 12-35
CHANNEL
GILFORD ISLAND
Km
0
1.5
3
6
9

Figure 17. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 12-35 & 12-37. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); 0=zero animals.

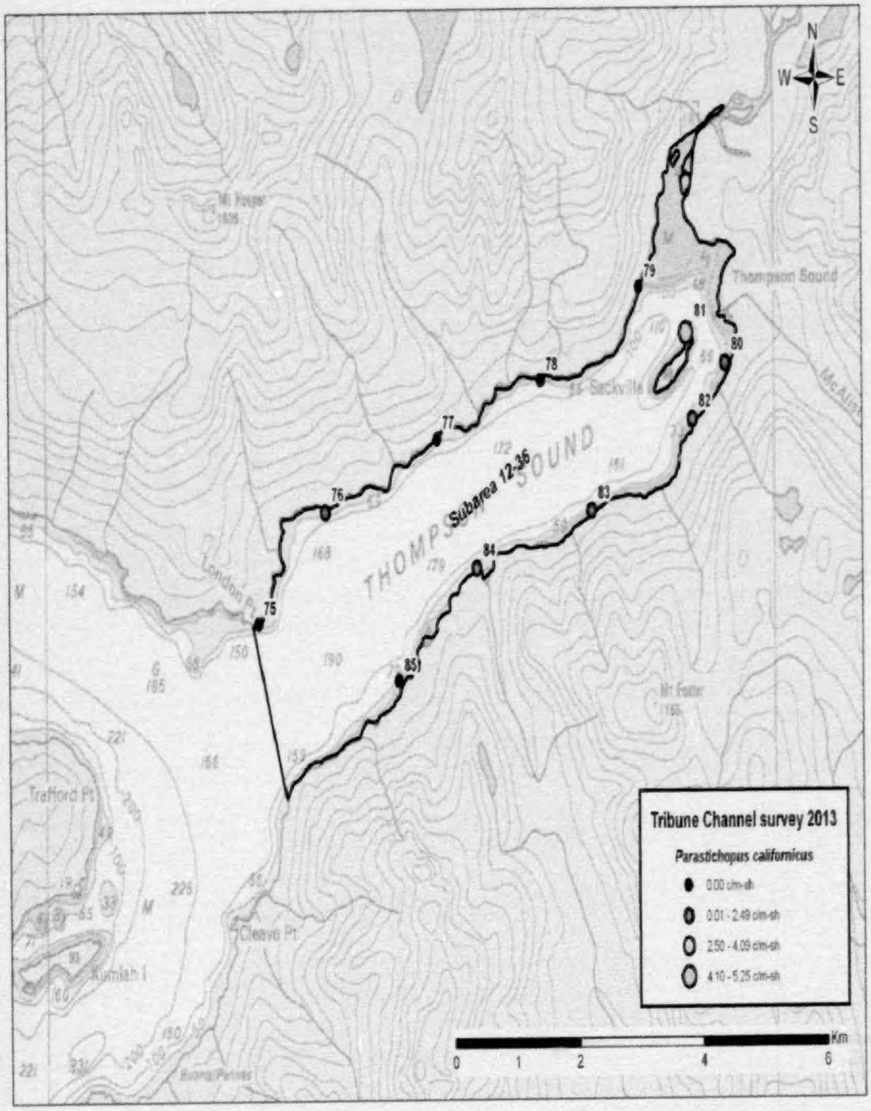
N
W
E
S
Thompson Sound
79
78
77
76
75
81
80
82
83
84
85
Sackville
Subarea 12-36
THOMPSON SOUND
London Pt
Mt Foster
1165
Trafford Pt
Cleave Pt
Kumlah I
Tribune Channel survey 2013
Parastichopus californicus
● 0.00 c/m-sh
0.01 - 2.49 c/m-sh
2.50 - 4.09 c/m-sh
4.10 - 5.25 c/m-sh
0
1
2
4
6
Km

Figure 18. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 12-36, surveyed as part of the Tribune Channel survey in 2013. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 c/m-sh and the Regional Baseline Density); green = productive locations (densities above the Regional Baseline Density).

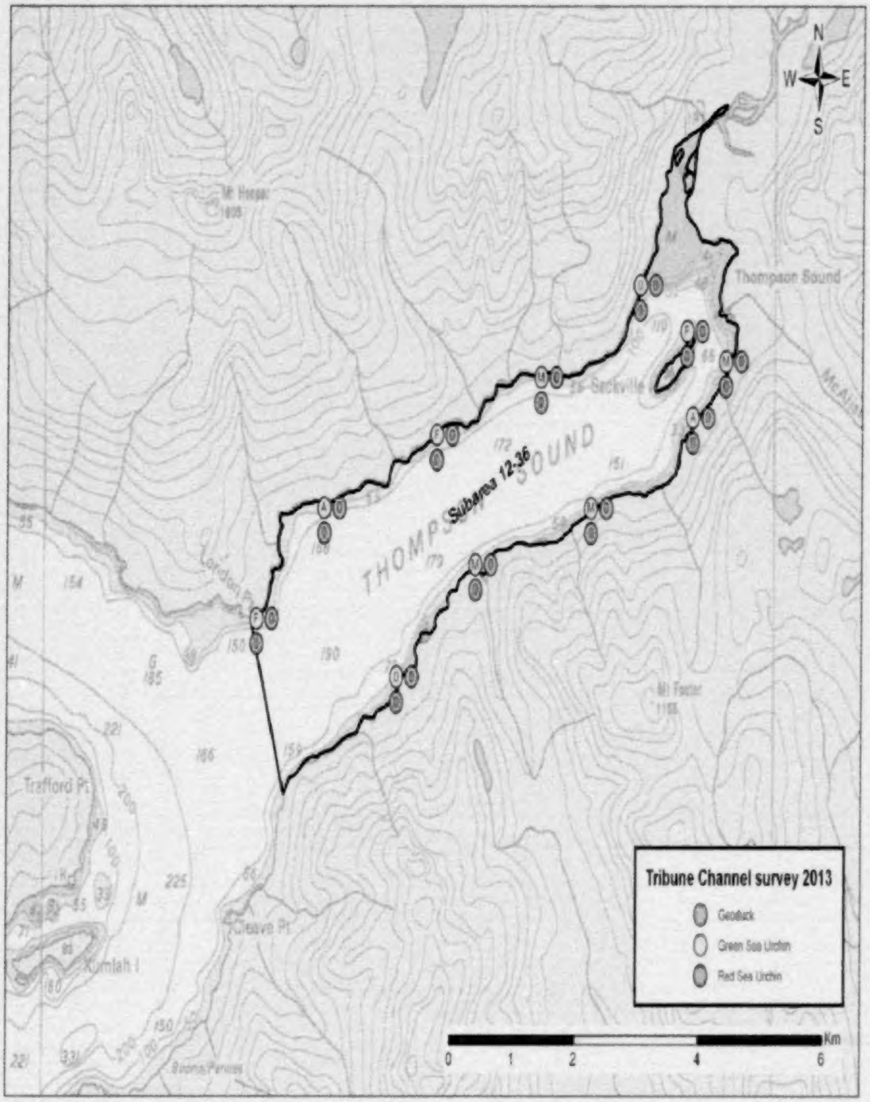
N
W
E
S
Mt Hesser
Thompson Sound
Sackville
Subarea 12-36
THOMPSON SOUND
London Pt
Trafford Pt
Cleave Pt
Kumlah I
Mt Foster
McAlister
Tribune Channel survey 2013
Geoduck
Green Sea Urchin
Red Sea Urchin
0
1
2
4
6
Km
A
M
F
0

Figure 19. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 12-36. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); 0=zero animals.

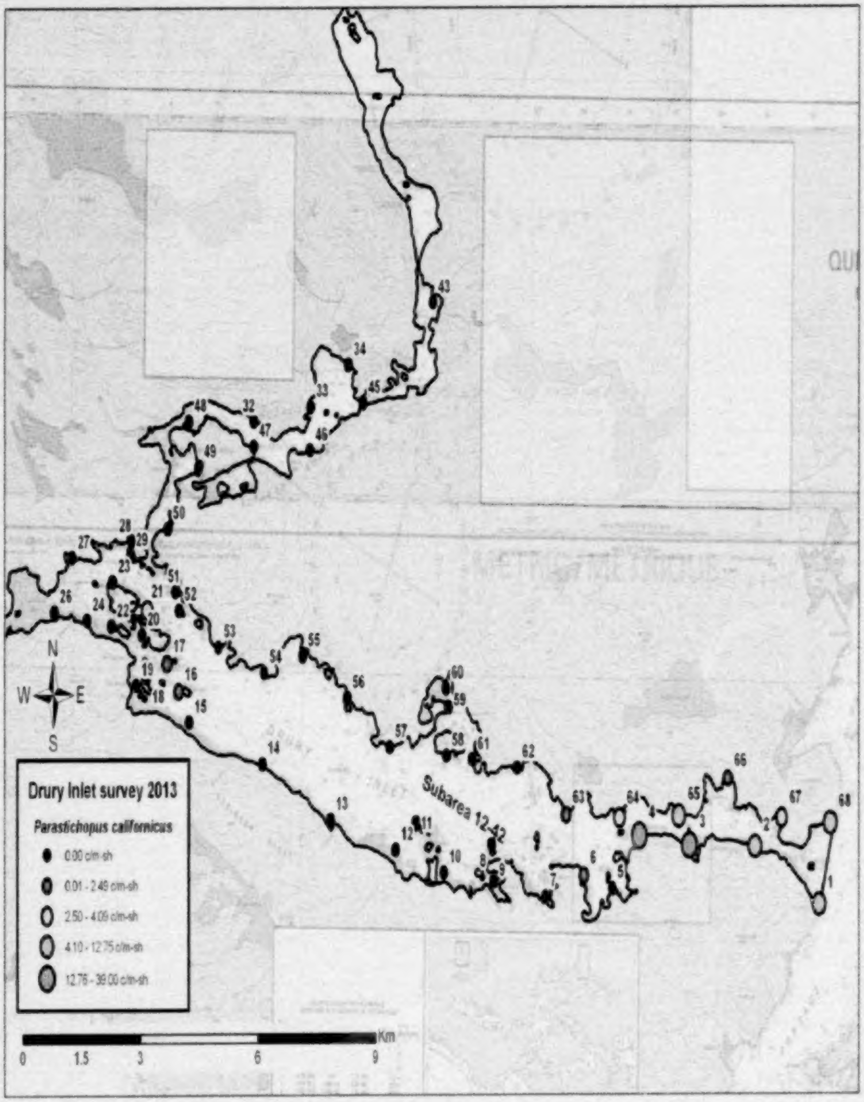
Drury Inlet survey 2013
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 4.09 c/m-sh
○ 4.10 - 12.75 c/m-sh
● 12.76 - 39.00 c/m-sh
N
W
E
S
Subarea 12-42
0
1.5
3
6
9
Km
QU
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
26
27
28
29
32
33
34
43
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
68

Figure 20. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 12-42, surveyed as part of the Drury Inlet survey in 2013. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and the Regional Baseline Density); green = productive locations (densities above the Regional Baseline Densities and 12.75 c/m-sh); blue = very productive locations (between 12.76 c/m-sh and the maximum observed density in the Subarea).

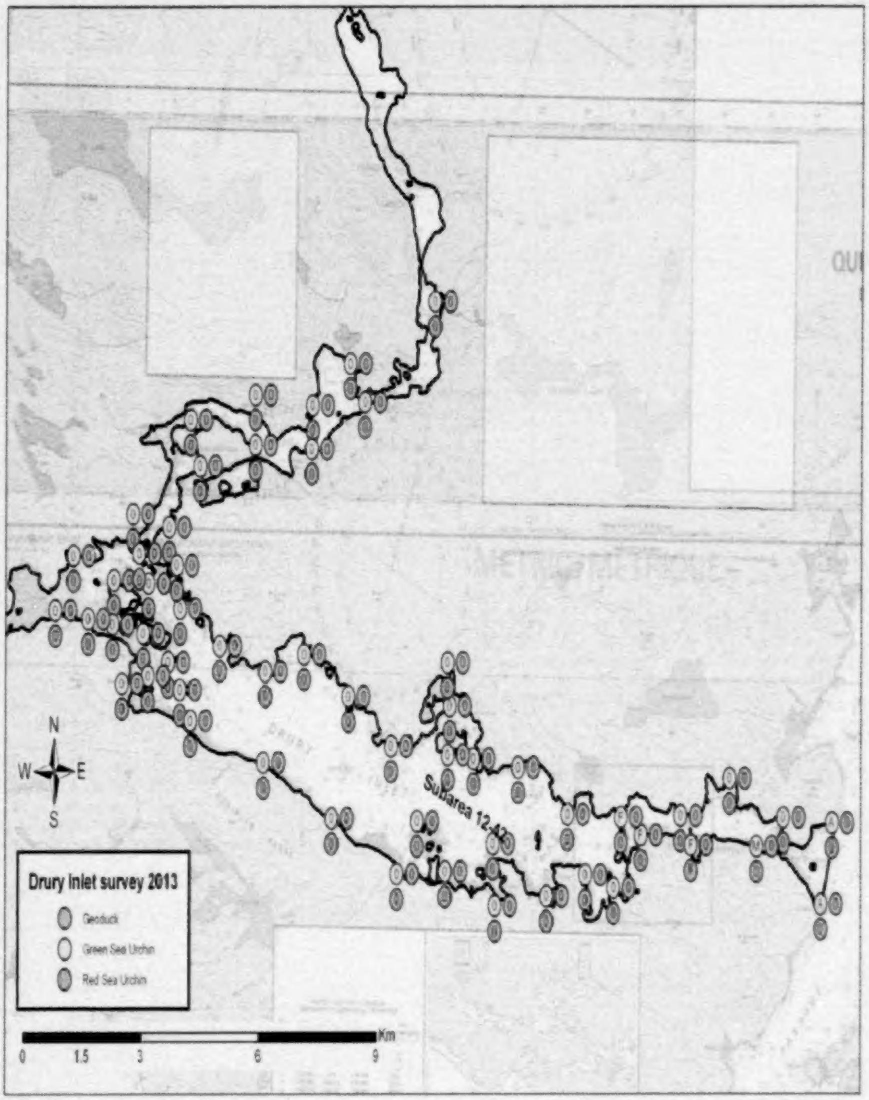
N
W
E
S
Subarea 12-42
Drury Inlet survey 2013
Geoduck
Green Sea Urchin
Red Sea Urchin
0
1.5
3
6
9
Km

Figure 21. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 12-42. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); 0=zero animals.

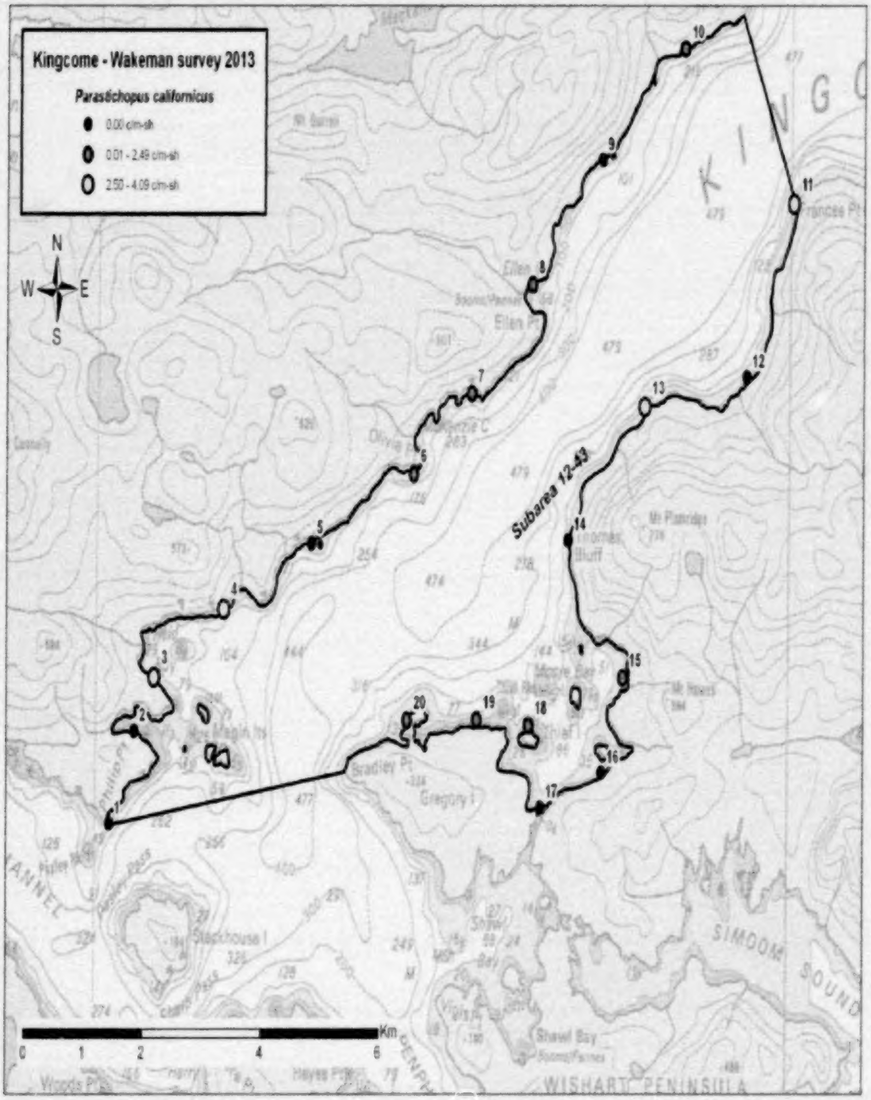
Kingcome - Wakeman survey 2013
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 4.09 c/m-sh
N
W
E
S
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
Subarea 12-43
K I N G C
Frances Pt
Ellen Pt
Olivia Pt
Bradley Pt
Gregory I
Stackhouse I
Moore Bay
Mt Hawes
Shawl Bay
SIMOOM SOUND
WISHART PENINSULA
Km
0
1
2
4
6

Figure 22. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 12-43, surveyed as part of the Kingcome-Wakeman survey in 2013. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and the Regional Baseline Density); green = productive locations (densities above the East Coast Regional Baseline Density).

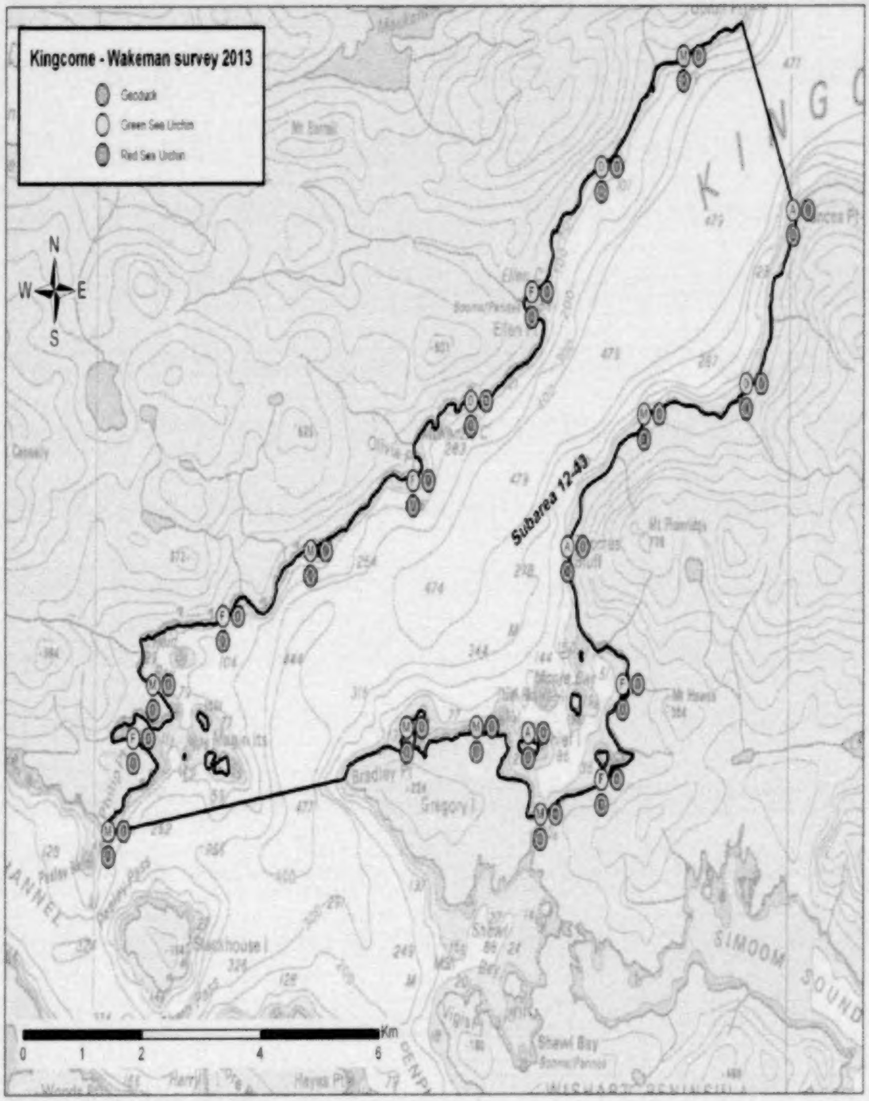
Kingcome - Wakeman survey 2013
Geoduck
Green Sea Urchin
Red Sea Urchin
N
W
E
S
K I N G
Subarea 12-43
Olivia Pt
Bradley Pt
Gregory I
Stackhouse I
Moore Bay
Shawl Bay
SIMOOM SOUND
0
1
2
4
6
Km

Figure 23. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in a portion of PFMA 12-43. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); 0=zero animals.

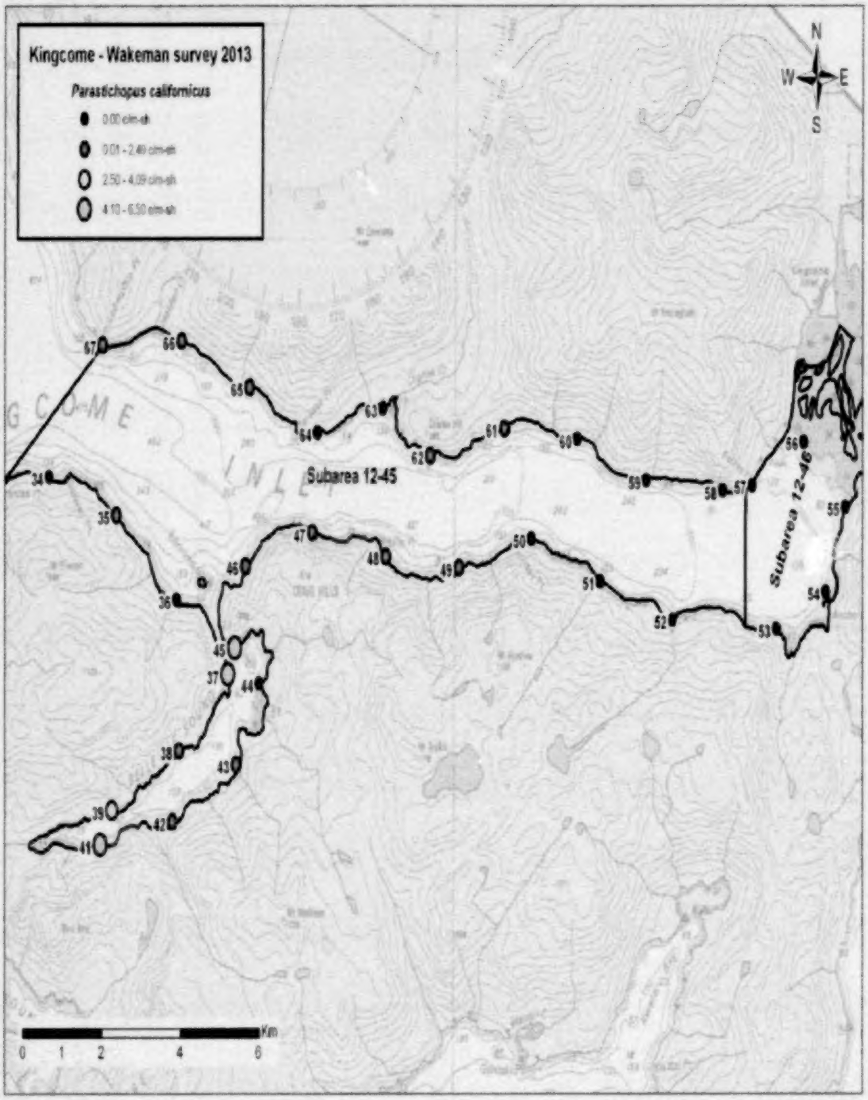
Kingcome - Wakeman survey 2013
Parastichopus californicus
0.00 c/m-sh
0.01 - 2.49 c/m-sh
2.50 - 4.09 c/m-sh
4.10 - 6.50 c/m-sh
N
W
E
S
KINGCOME INLET
Subarea 12-45
Subarea 12-46
34
35
36
37
38
39
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
64
65
66
67
Km
0
1
2
4
6

Figure 24. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 12-45 and 12-46, surveyed as part of the Kingcome-Wakeman survey in 2013. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5c/m-sh and the Regional Baseline Density); green = productive locations (between 4.10 c/m-sh and the maximum observed density in the Subareas).

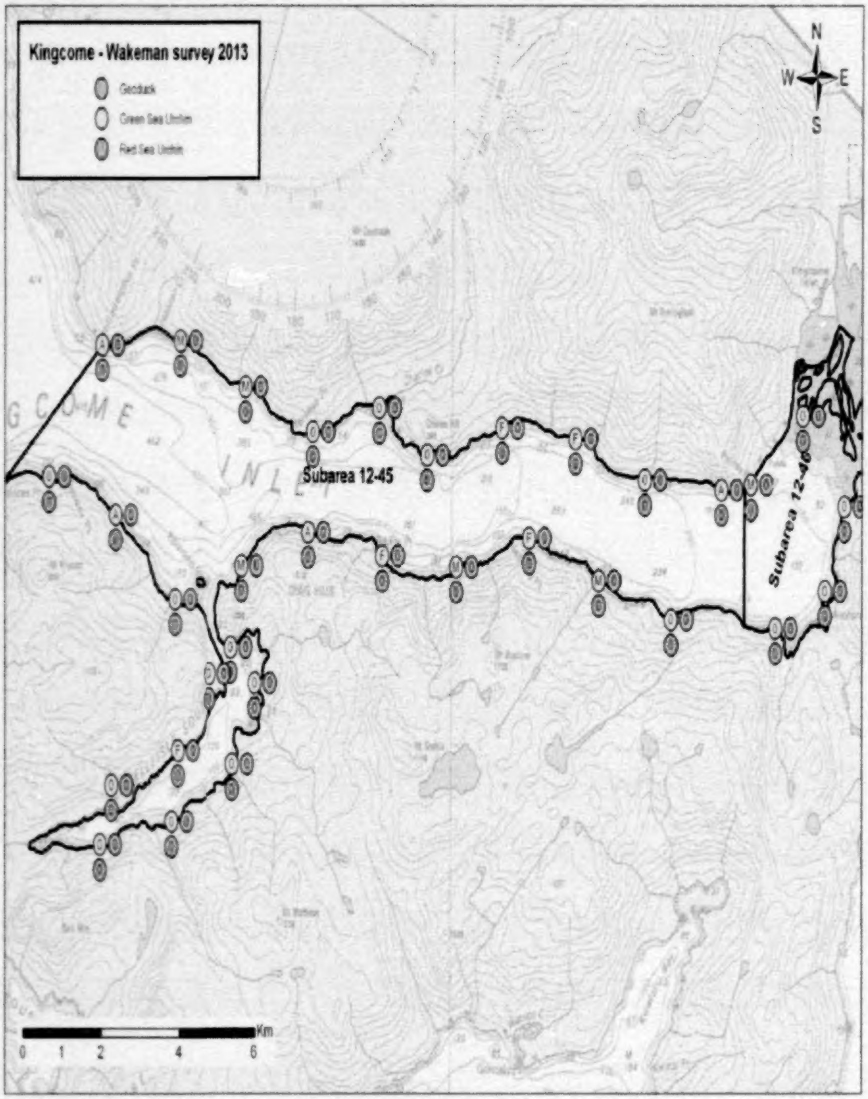
Kingcome - Wakeman survey 2013
Geoduck
Green Sea Urchin
Red Sea Urchin
N
W
E
S
G C O M E
I N L E T
Subarea 12-45
Subarea 12-46
Km
0
1
2
4
6

Figure 25. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 12-45 and 12-46. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10animals); 0=zero animals.

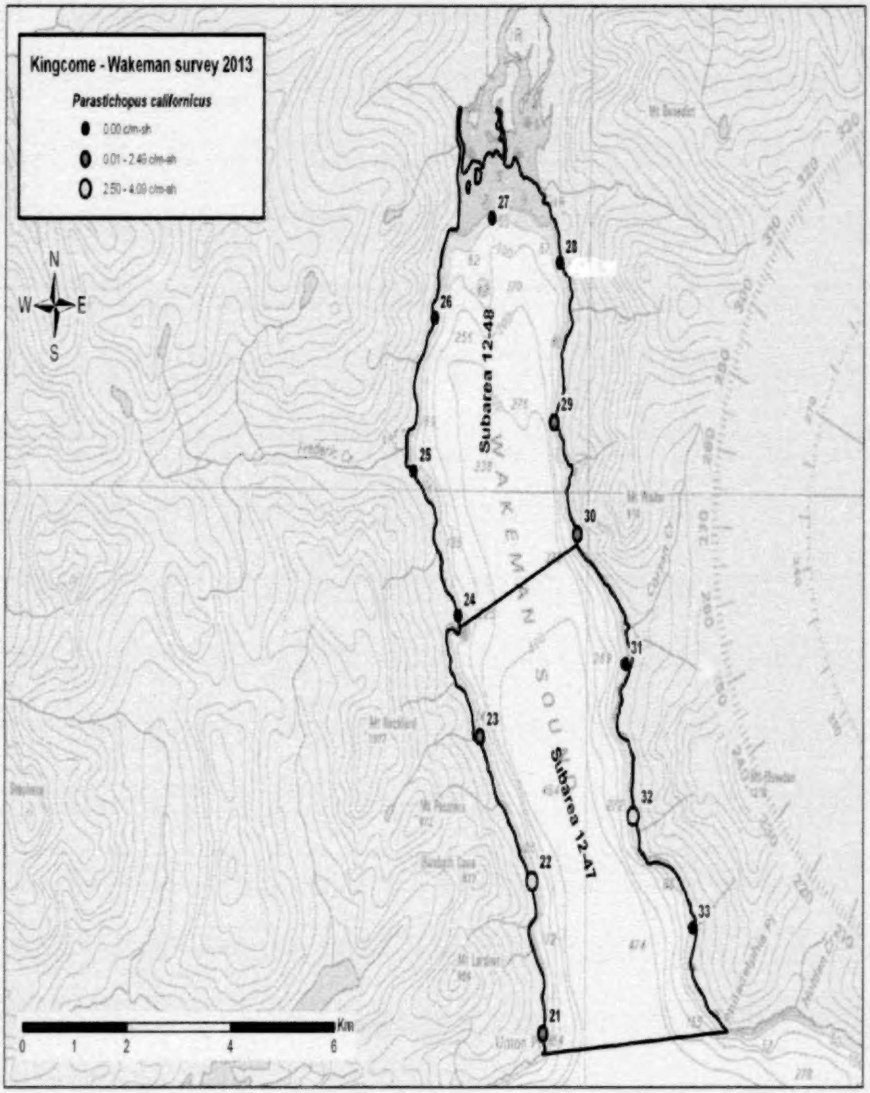
Kingcome - Wakeman survey 2013
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.46 c/m-sh
○ 2.50 - 4.09 c/m-sh
N
W
E
S
Subarea 12-48
Subarea 12-47
W A K E M A N
S O U
21
22
23
24
25
26
27
28
29
30
31
32
33
Km
0
1
2
4
6

Figure 26. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 12-47 and 12-48, surveyed as part of the Kingcome-Wakeman survey in 2013. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and the Regional Baseline Density); green = productive locations (between the Regional Baseline Density and the maximum observed density in the Subareas).

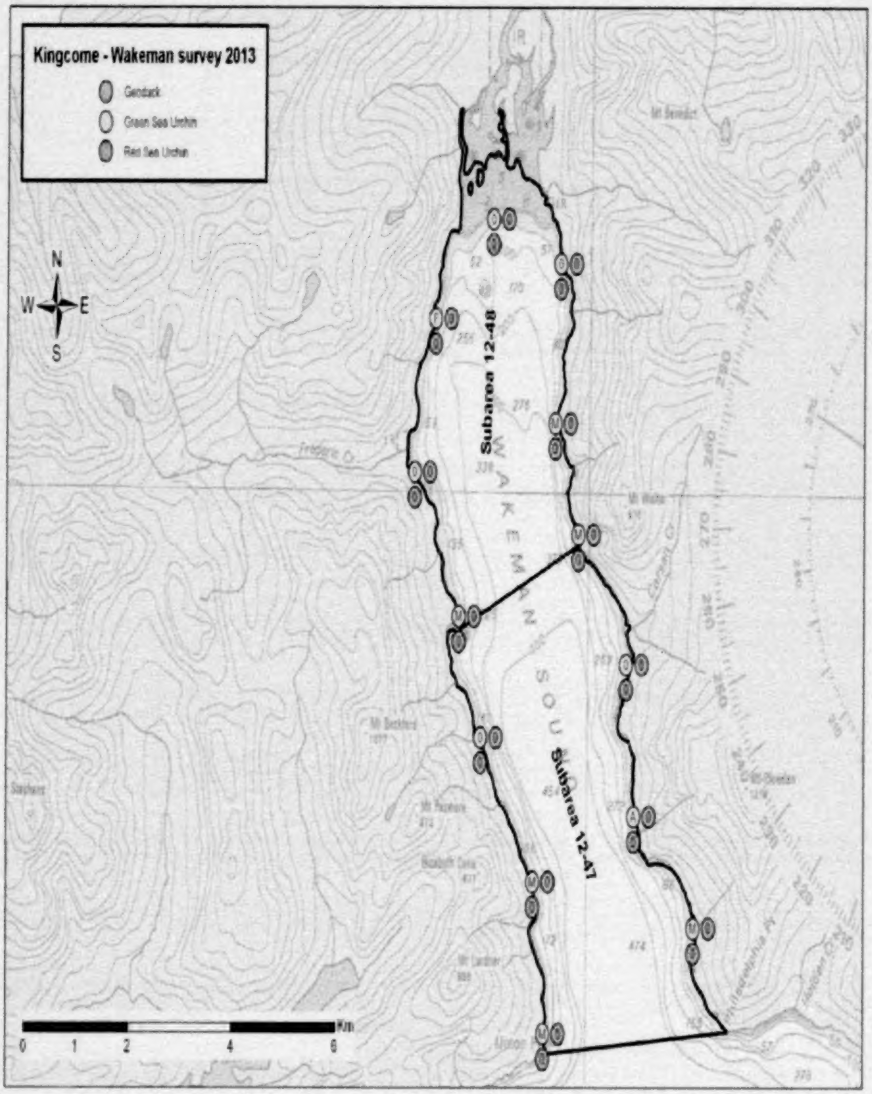
Kingcome - Wakeman survey 2013
Geoduck
Green Sea Urchin
Red Sea Urchin
N
W
E
S
Subarea 12-48
Subarea 12-47
WAKEMAN SOUND
0 1 2 4 6 Km

Figure 27. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 12-47 and 12-48. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); 0=zero animals.

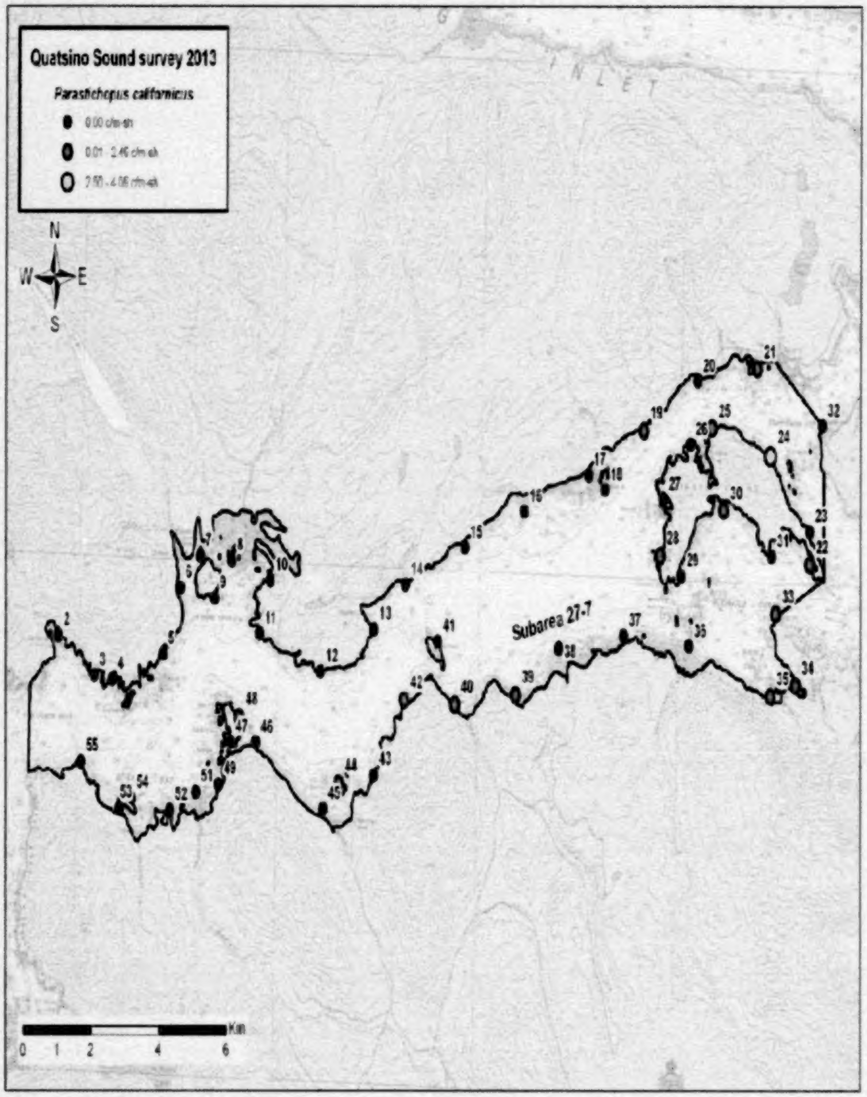
Quatsino Sound survey 2013
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.46 c/m-sh
○ 2.50 - 4.06 c/m-sh
N
W
E
S
INLET
Subarea 27-7
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
51
52
53
54
55
Km
0
1
2
4
6

Figure 28. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 27-7, surveyed as part of the Quatsino Sound survey in 2013. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and 4.09 c/m-sh); green = productive locations (densities between 4.10c/m-sh and the maximum density observed in the Quatsino Sound Subareas).

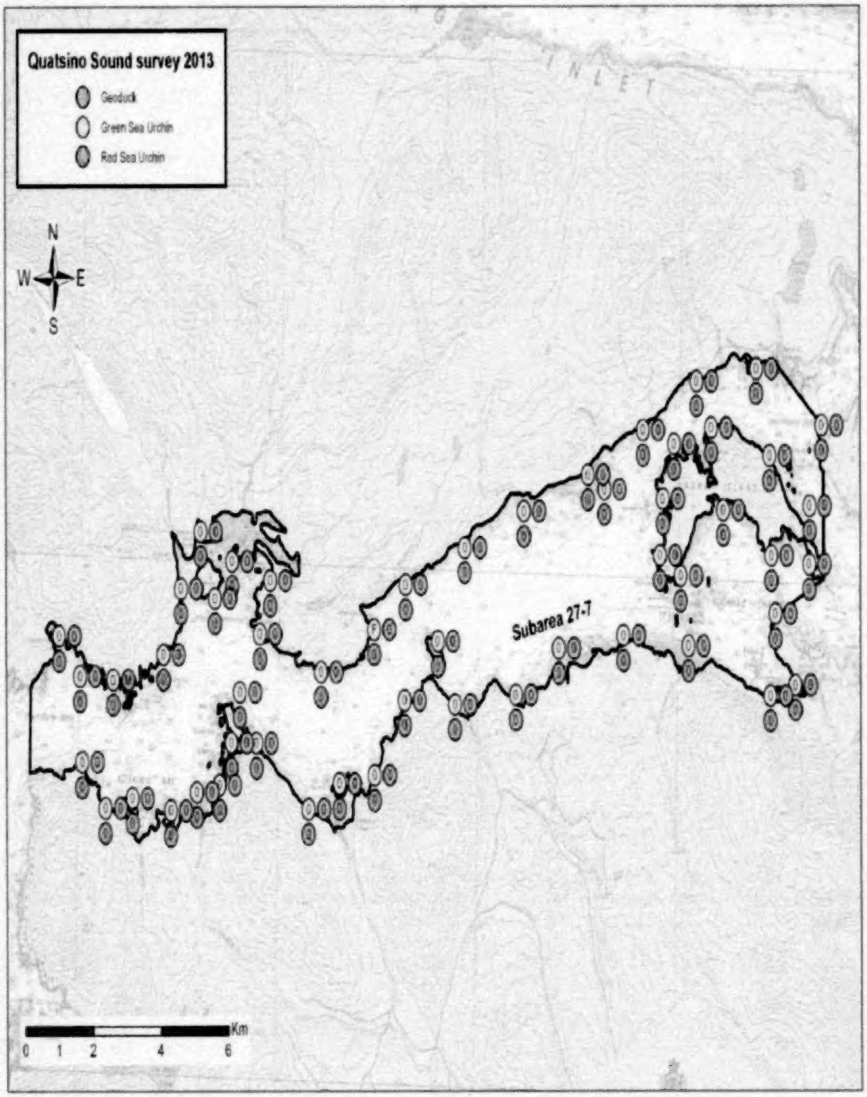
Quatsino Sound survey 2013
Geoduck
Green Sea Urchin
Red Sea Urchin
N
W
E
S
INLET
Subarea 27-7
Km
0
1
2
4
6

Figure 29. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 27-7. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); 0=zero animals.

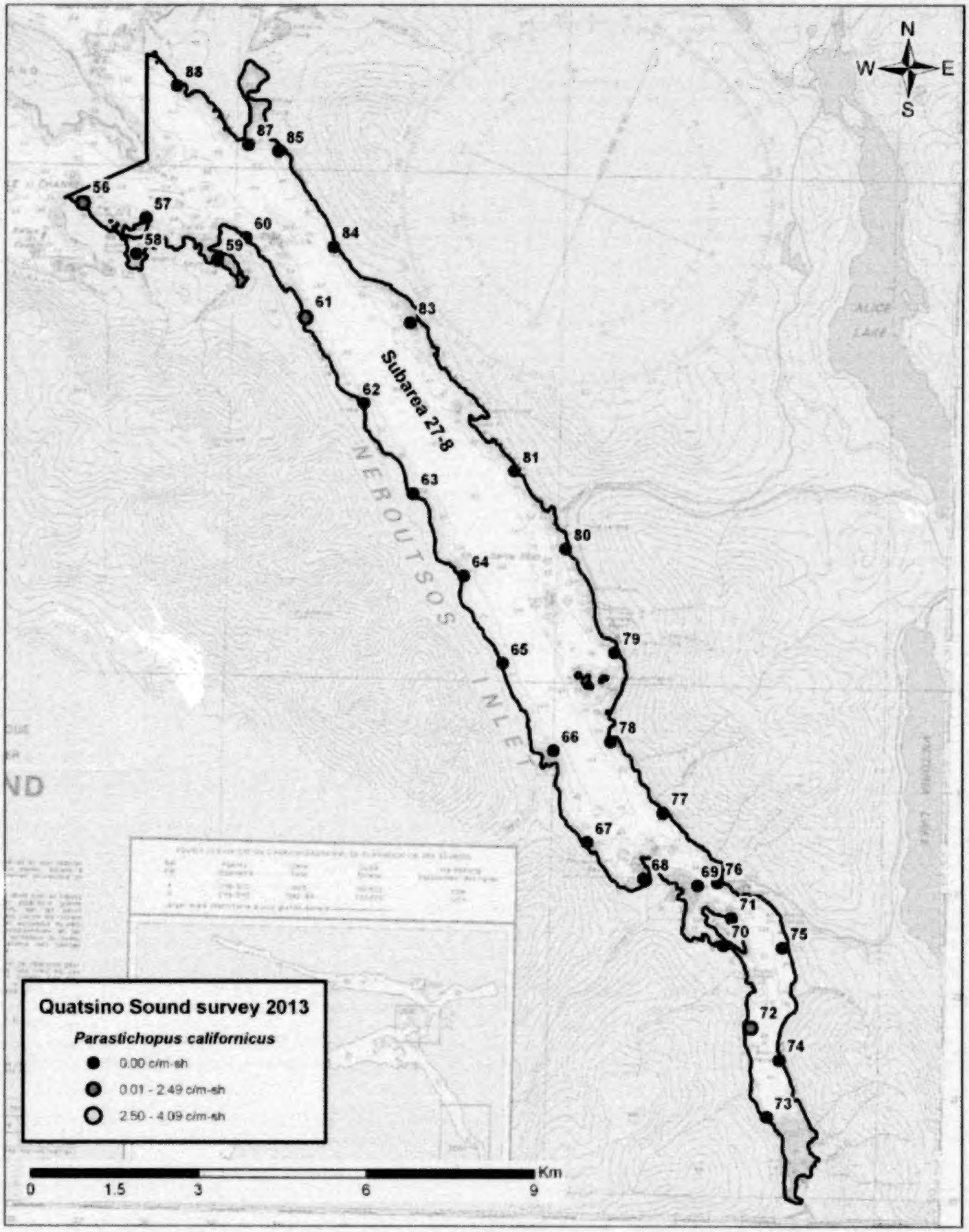
N
W
E
S
88
87
85
56
57
58
59
60
84
61
83
Subarea 27-8
62
NEROUTSOS INLET
81
63
80
64
79
65
78
66
77
67
68
69
76
71
70
75
72
74
73
ALICE LAKE
Quatsino Sound survey 2013
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 4.09 c/m-sh
0
1.5
3
6
9
Km

Figure 30. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of ***Parastichopus californicus*** in PFMA 27-8, surveyed as part of the Quatsino Sound survey in 2013. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 c/m-sh and 4.09 c/m-sh); green = productive locations (densities between 4.10c/m-sh and the maximum density observed in the Quatsino Sound Subareas).

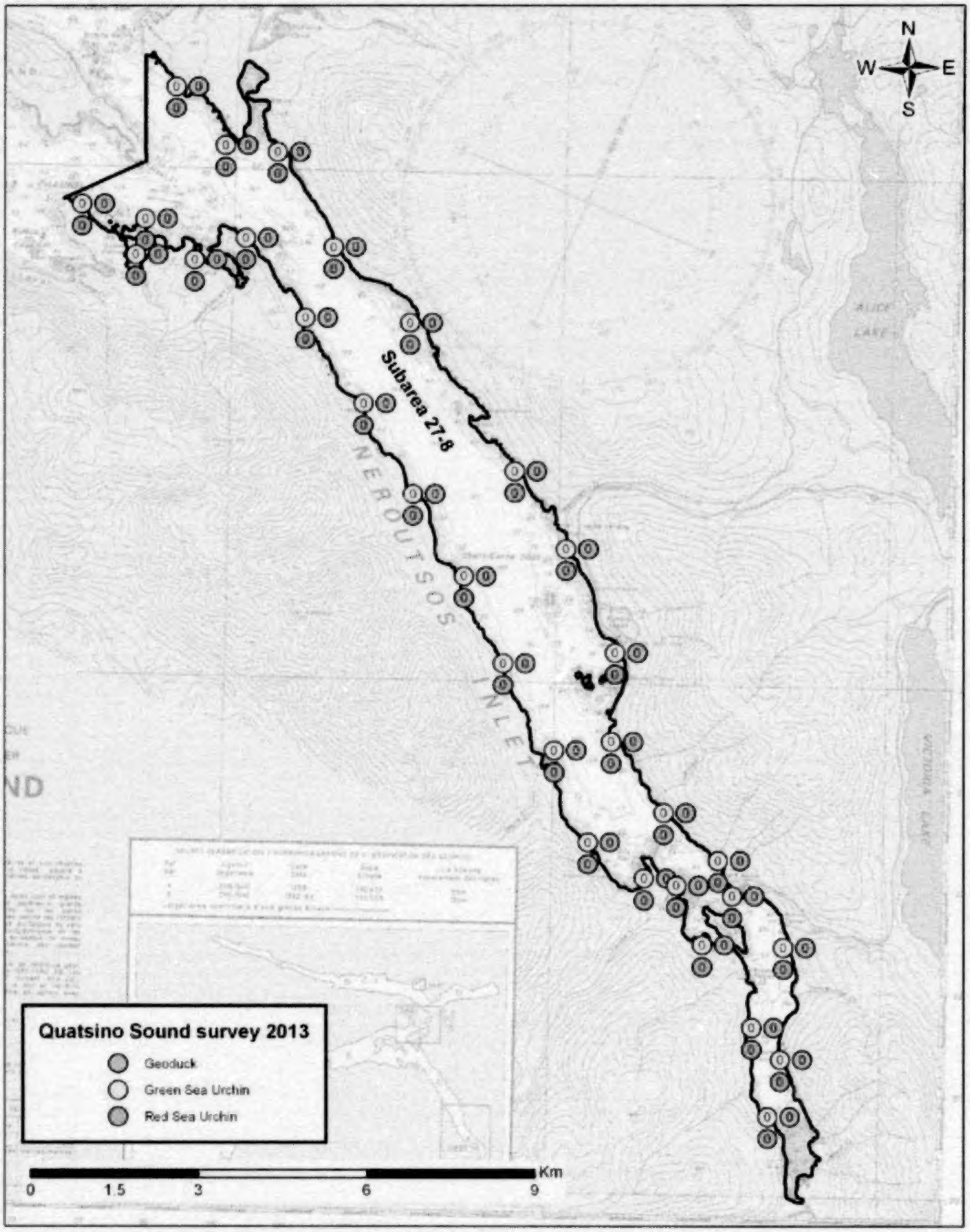
N
W
E
S
Subarea 27-8
NEROUTSOS INLET
ALICE LAKE
VICTORIA LAKE
Quatsino Sound survey 2013
Geoduck
Green Sea Urchin
Red Sea Urchin
0
1.5
3
6
9
Km

Figure 31. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 27-8. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); 0=zero animals.

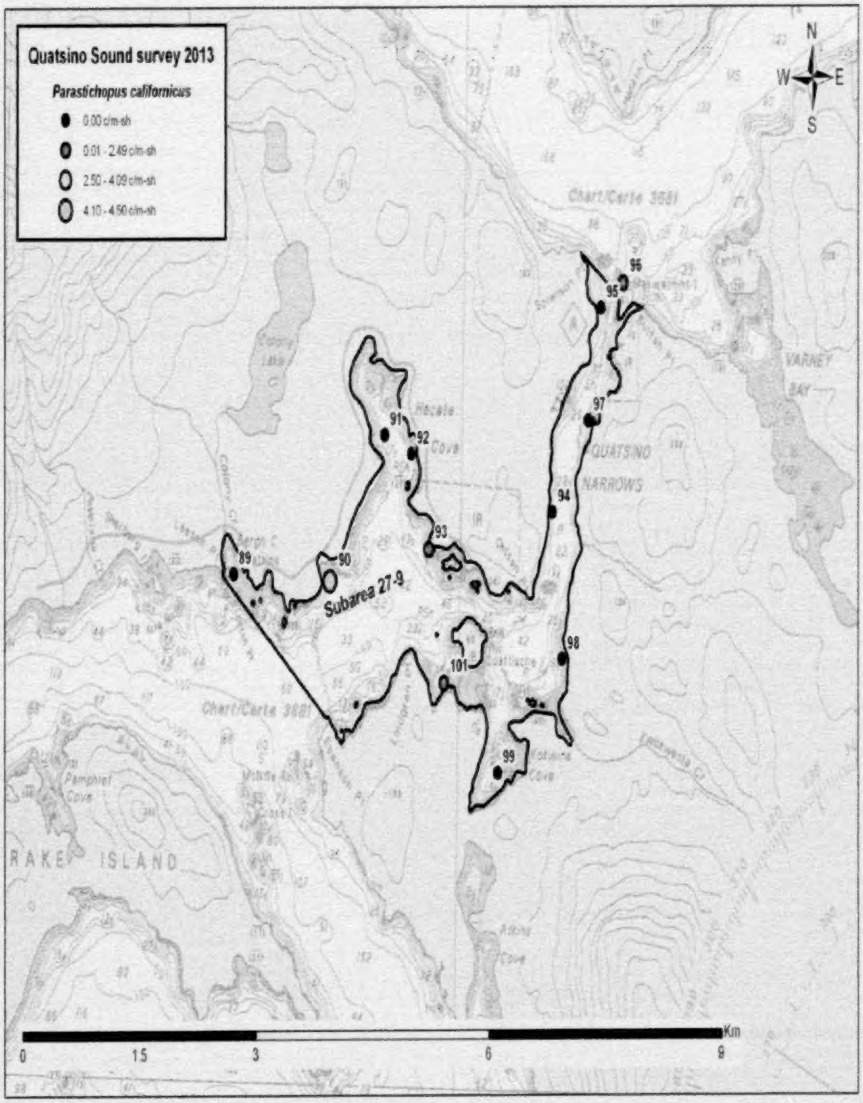
Quatsino Sound survey 2013
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 4.09 c/m-sh
○ 4.10 - 4.50 c/m-sh
N
W
E
S
Subarea 27-9
89
90
91
92
93
94
95
96
97
98
99
101
Hecate Cove
QUATSINO NARROWS
VARNEY BAY
Chart/Carte 3681
RAKE ISLAND
Pamphlet Cove
Koprino Cove
Atkins Cove
0
1.5
3
6
9
Km

Figure 32. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 27-9, surveyed as part of the Quatsino Sound survey in 2013. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and 4.09 c/m-sh); green = productive locations (densities between 4.10c/m-sh and the maximum density observed in the Quatsino Sound Subareas).

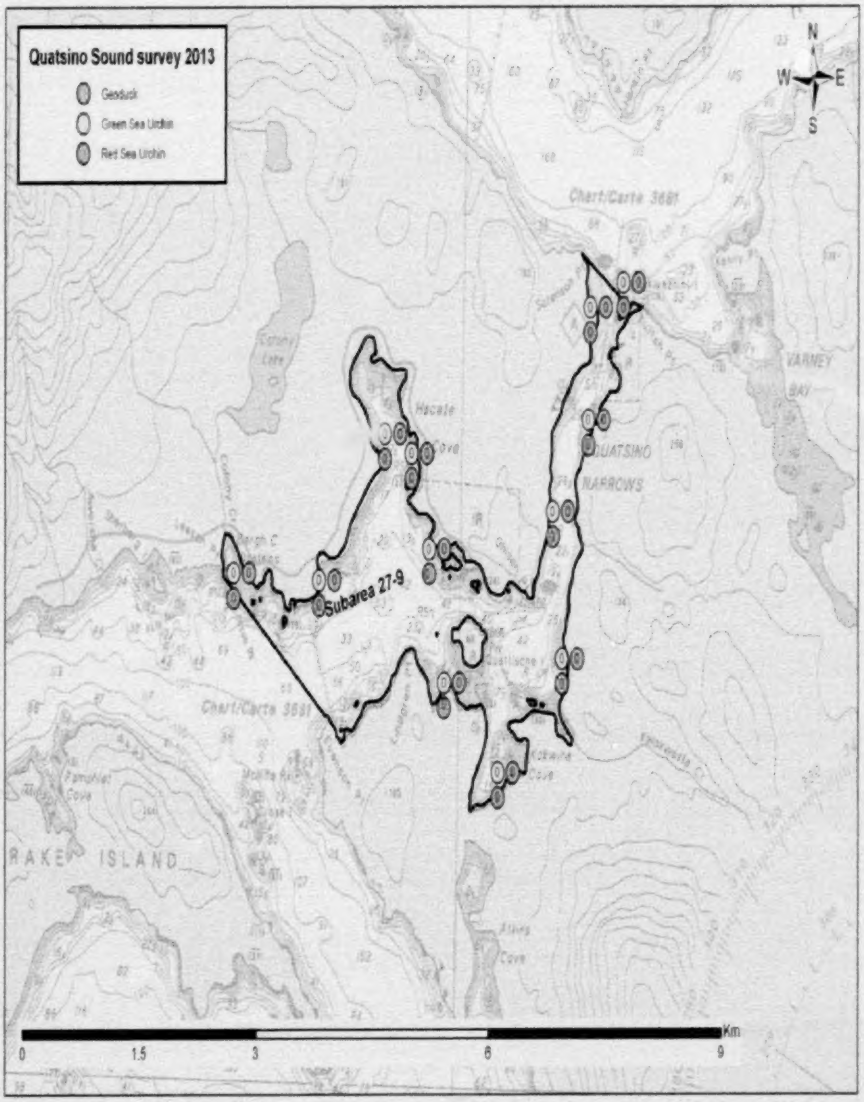
Quatsino Sound survey 2013
Geoduck
Green Sea Urchin
Red Sea Urchin
N
W
E
S
Chart/Carte 3681
Hecate
Cove
QUATSINO
NARROWS
VARNEY
BAY
Subarea 27-9
Chart/Carte 3681
RAKE ISLAND
Atkins
Cove
Km
0
1.5
3
6
9

Figure 33. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 27-9. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); 0=zero animals.

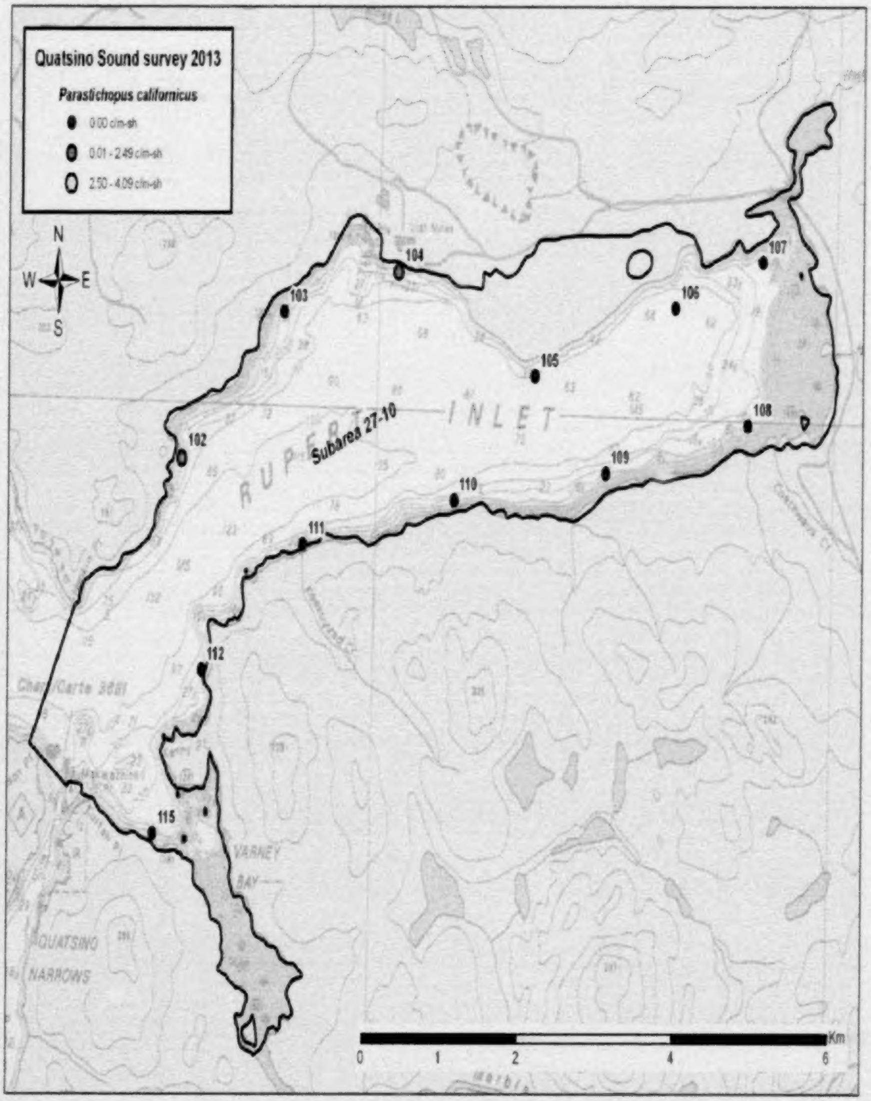
Quatsino Sound survey 2013
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 4.09 c/m-sh
N
W
E
S
104
107
103
106
105
RUPERT INLET
Subarea 27-10
108
102
109
110
111
112
Chart/Carte 3681
115
VARNEY BAY
QUATSINO NARROWS
0
1
2
4
6
Km

Figure 34. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 27-10, surveyed as part of the Quatsino Sound survey in 2013. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and 4.09 c/m-sh); green = productive locations (densities between 4.10c/m-sh and the maximum density observed in the Quatsino Sound Subareas).

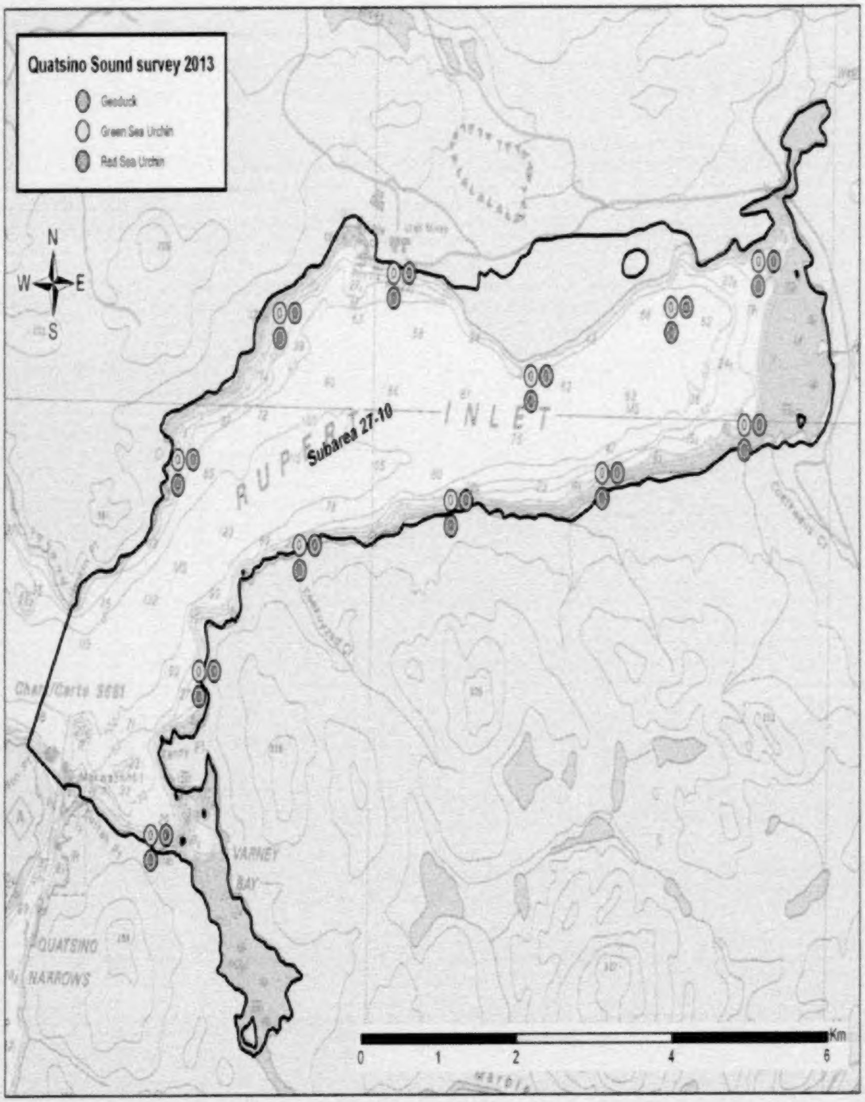
Quatsino Sound survey 2013
Geoduck
Green Sea Urchin
Red Sea Urchin
N
W
E
S
RUPERT INLET
Subarea 27-10
VARNEY BAY
QUATSINO NARROWS
Chart/Carte 3681
Km
0
1
2
4
6

Figure 35. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 27-10. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); 0=zero animals.

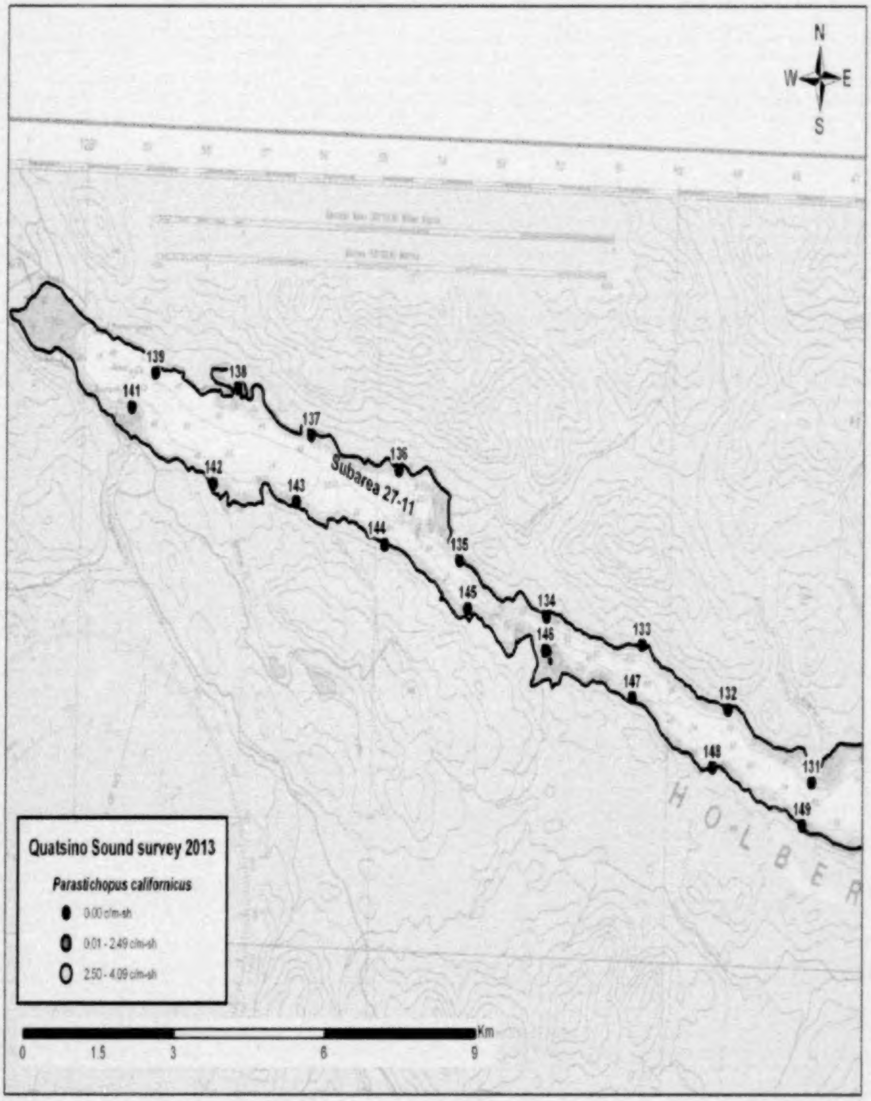
N
W
E
S
139
138
141
137
136
Subarea 27-11
142
143
144
135
145
134
146
133
147
132
148
131
149
HOLBER
Quatsino Sound survey 2013
Parastichopus californicus
0.00 c/m-sh
0.01 - 2.49 c/m-sh
2.50 - 4.09 c/m-sh
Km
0
1.5
3
6
9

Figure 36a. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 27-11, surveyed as part of the Quatsino Sound survey in 2013. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and 4.09 c/m-sh); green = productive locations (densities between 4.10c/m-sh and the maximum density observed in the Quatsino Sound Subareas).

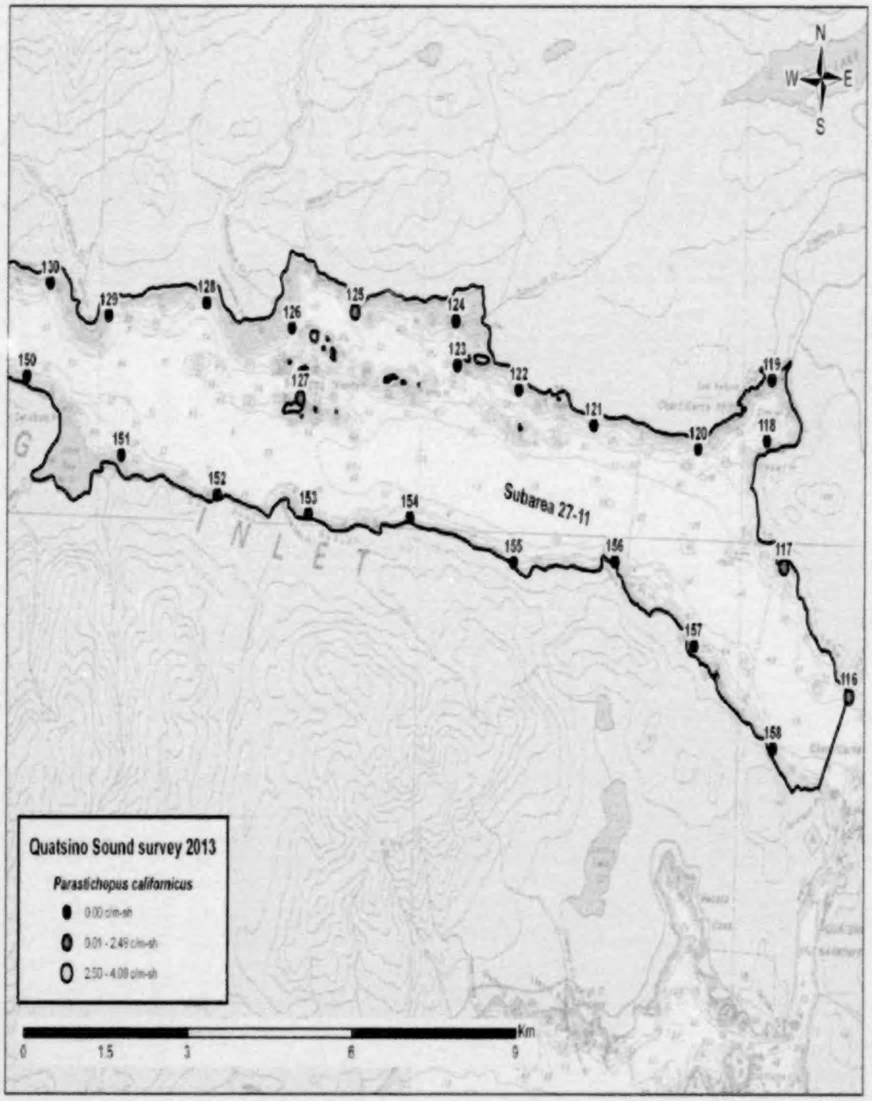
N
W
E
S
130
129
128
126
125
124
123
127
122
121
120
119
118
150
151
152
153
154
155
156
117
157
116
158
Subarea 27-11
G
I N L E T
Quatsino Sound survey 2013
Parastichopus californicus
● 0.00 c/m-sh
● 0.01 - 2.49 c/m-sh
○ 2.50 - 4.08 c/m-sh
0
1.5
3
6
9
Km

Figure 36b. Linear density (sea cucumbers per metre of shoreline; c/m-sh), of *Parastichopus californicus* in PFMA 27-11, surveyed as part of the Quatsino Sound survey in 2013. Each coloured dot indicates the locations of a survey transect identified by the transect number above the dot. Black = zero; red = low density (<2.5 c/m-sh); yellow = medium density (between 2.5 and 4.09 c/m-sh); green = productive locations (densities between 4.10c/m-sh and the maximum density observed in the Quatsino Sound Subareas).

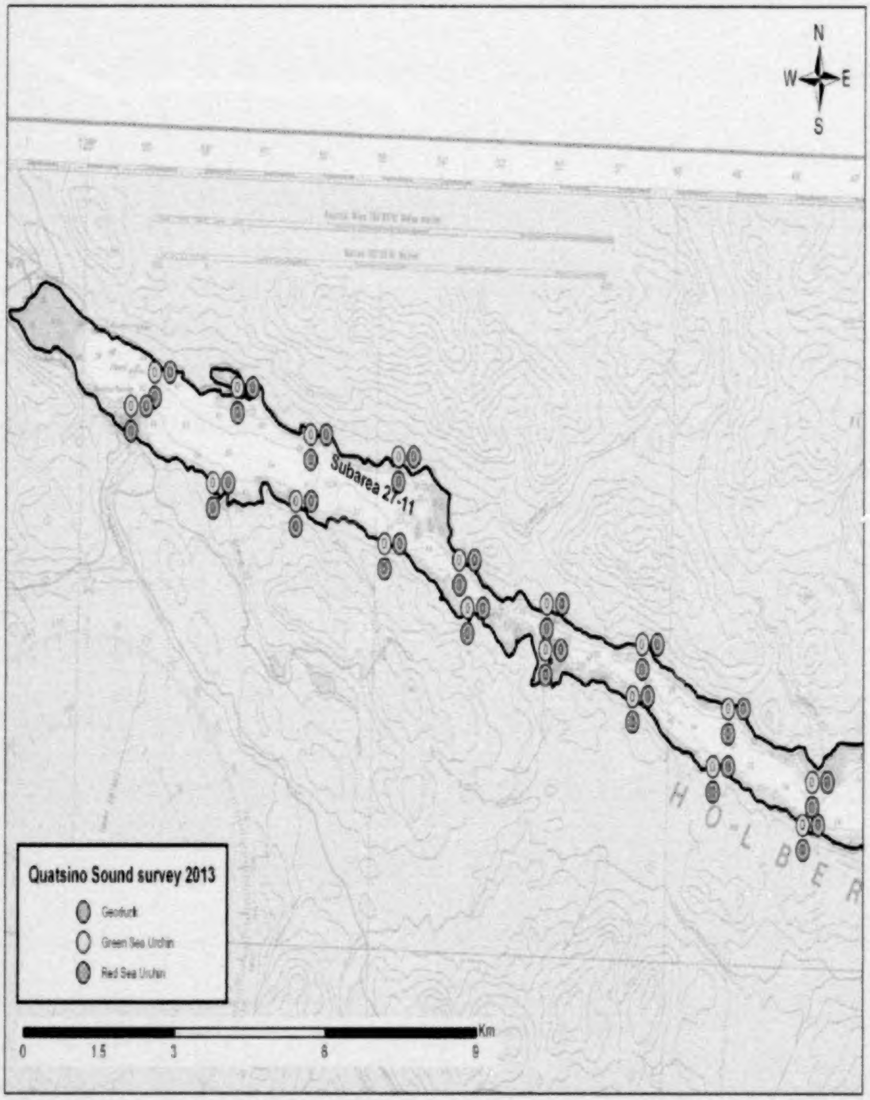
N
W
E
S
Subarea 27-11
H O L B E R
Quatsino Sound survey 2013
Geoduck
Green Sea Urchin
Red Sea Urchin
0
1.5
3
6
9
Km

Figure 37a. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 27-11. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); 0=zero animals.

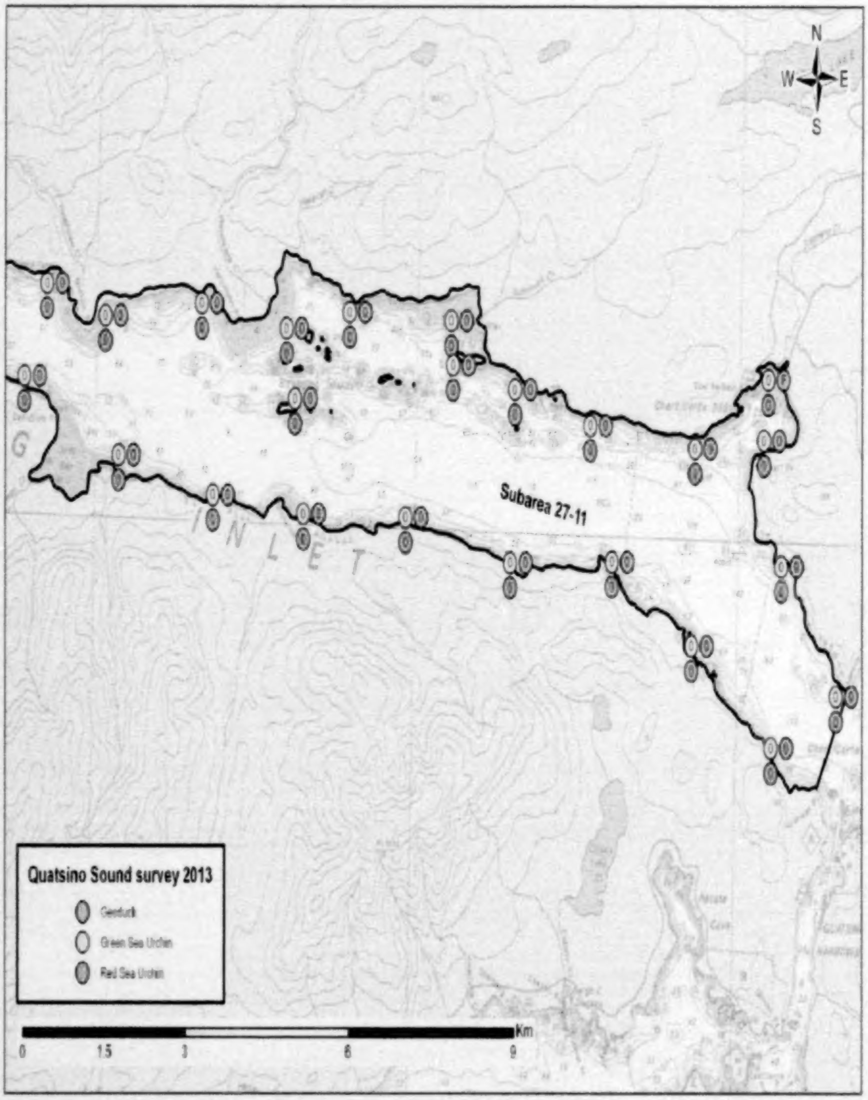
N
W
E
S
Subarea 27-11
INLET
Quatsino Sound survey 2013
Geoduck
Green Sea Urchin
Red Sea Urchin
0
1.5
3
6
9
Km

Figure 37b. Relative abundance of Red Sea Urchin, Green Sea Urchin and Geoduck on transects surveyed for sea cucumber in PFMA 27-11. The number of animals observed while swimming the transect is noted and given an abundance category: A=Abundant (101+ animals); M=Many (11-100 animals); F=Few (1-10 animals); 0=zero animals.